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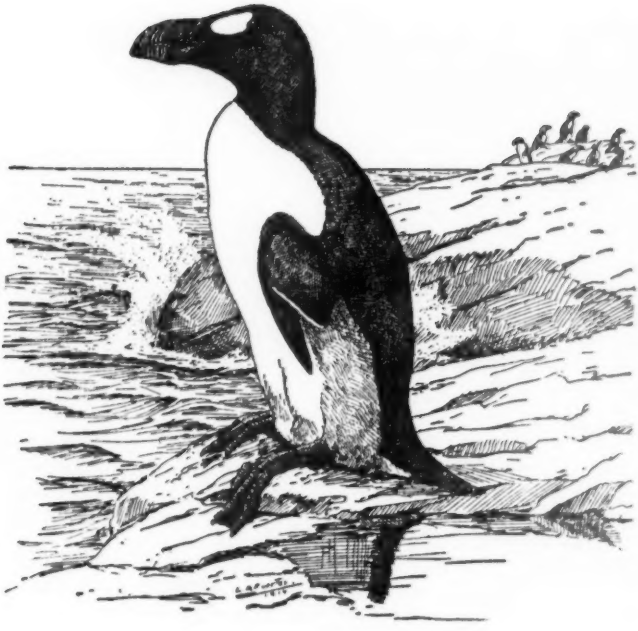

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THE GAMBEL'S SPARROW AT MOUNTAIN VILLAGE, ALASKA

BY BARBARA BLANCHARD OAKESON

FIELD work for this paper was done at Mountain Village, Alaska (lat. 62° 07′ N.), the settlement on the lower Yukon from which Mr. Henry C. Kyllingstad made explorations preparatory to the discovery of the nest of the Bristle-thighed Curlew (Allen and Kyllingstad, 1949). I chose this place for my work first, because arrival and departure dates for Gambel's Sparrows (*Zonotrichia leucophrys gambeli*) for a six-year period were available through the kindness of Mr. Kyllingstad; second, because meteorological data had been recorded there for several years; and third, because the lateness of the spring at Mountain Village, compared with that at stations of similar latitude farther inland, seemed likely to reveal the capacity of the Gambel's Sparrow to compress its breeding cycle. Mr. Kyllingstad had earlier estimated this species as second in abundance of all the migratory passerines breeding there. Unfortunately, the spring of 1950, when the field work was done, coincided with a low point in numbers. This fitted in with the many reports from southern California bird-banders of abnormally few immature Gambel's Sparrows trapped the previous winter. Beyond Mountain Village the Yukon fans out into broad flats unsuitable for this species, and the country back of the first row of hills above the village is also unsuitable. The sparse breeding population in 1950 was therefore not augmented by influx from adjacent land, nor could I extend my working area to include more nesting pairs. The low population level that year may account in part for the high percentage of young fledged.

MATERIAL AND METHODS

Three months were spent in Mountain Village, from late April through July, collecting, banding, and watching Gambel's Sparrows.

Plants were collected, and the vegetational changes were photographed weekly. Nine nesting pairs, most of which were marked recognizably with colored bands, were watched from the start of nesting until they fledged their young. The birds collected for anatomical analysis were taken on the day of, or within three days of, arrival, and were prepared as described in a previous paper (Oakeson, 1953). Five males were taken in late June and early July to find the approximate time of testis regression.

Data for the curves of daylight and hours of possible sunshine are extrapolated for latitude 62° N. from the figures for latitude 60° N. in the American Ephemeris for 1953. Data for the other climatic factors were taken from the U. S. Weather Bureau's Bulletin on Climatological Data for Alaska.

ENVIRONMENT

Topography.—Mountain Village occupies a narrow strip about three miles long on the north bank of the Yukon, 120 miles from its mouth, where the river bends north around a range of hills which come down to the water's edge. Most of the three-mile strip was incorporated into territories of Gambel's Sparrows. After the disappearance of snow and ice, a cross-section of the terrain, starting at the river, would pass through a narrow rocky beach, up the river bank, which is only a few feet high in most places, and over gently sloping hills, with flat or rounded tops. The "mountain," a hill 500 feet high behind the village, is steeper than the rest. Little streams, often not more than a few feet wide except at the mouth, run into the river every few hundred yards. On the more poorly drained hilltops are many small ponds.

Climate.—Meteorological data are graphed in figures 1 and 2. No adequate idea of the climate can be obtained without considering the wind velocity and the great proportion of the time the wind blows, but this has not been recorded systematically until recently. Except for three calm days, the wind blew every day of the three months I spent there, the highest velocity recorded being 43 miles per hour. Army observers had recorded winds of up to 100 miles per hour on top of the "mountain."

Vegetational Pattern.—Wherever White-crowned Sparrows nest, whether in central California, at the Canadian border, or in Alaska, the vegetational pattern is in broad outline the same: the essential elements are bare ground, grass or grass mixed with annual and small perennial flowering plants, and extensive clumps of dense shrubbery.

At Mountain Village, bare forage ground was not always incorporated into the nesting territory. For pairs living upland from the village, the nearest open ground lay a mile or so below at the river's edge, and in such cases the pairs flew back and forth between nesting and foraging grounds through the areas of other Gambel's Sparrows, which were never seen to protest.

At the upper edge of the beach grow flowering annuals and scrub alders. On the river bank and up the slopes just above are dense stands of grass mixed with other annuals, ferns, and dwarf perennials. The slopes adjacent to most of the houses are burned each spring, and these support almost pure stands of grass. Willow is the dominant shrub along the streams, giving way to alder on the steeper slopes, although both frequently occur together. The higher slopes and better drained hilltops support dense mats of dwarf perennials. In poorly drained areas on hilltops grow several species of sedge. No coniferous trees occur at Mountain Village.

Passerine Associates.—The commonest associate of the Gambel's Sparrow was the Savannah Sparrow (*Passerculus sandwichensis*). Nests of the Fox Sparrow (*Passerella iliaca*), the Tree Sparrow (*Spizella arborea*), and the Common Redpoll (*Acanthis flammea*), a permanent resident, were also found in territories of Gambel's Sparrows.

Natural Enemies.—Few potential natural enemies occurred at Mountain Village the spring I was there. No hawks of the genus *Accipiter* were seen. A pair of Canada Jays was seen once. Horned Owls were heard calling from the south bank of the Yukon, but none was seen or heard on the village side. Jaegers commonly flew over the upland tundra, but kept away from the village. Weasels were reduced to the minimum by trapping, and of course there were no snakes. The safety of the village for nesting Gambel's Sparrows, for that season at least, is borne out by the high percentage of young fledged.

ARRIVAL

Dates.—Gambel's Sparrows destined to breed at Mountain Village arrived there in 1950 over a period of at least 19 days. The first two males came May 9. One was color-banded and followed through the nesting cycle. From then until May 25, males filtered in gradually. The average arrival date for 17 males was May 15. The females arrived between May 17 and May 28, and the average arrival date for 11 birds was May 23. These data accord closely with those of Mr. Kyllingstad (personal communication) for six years between 1942 and 1948. I assume his records of early arrivals are for males.

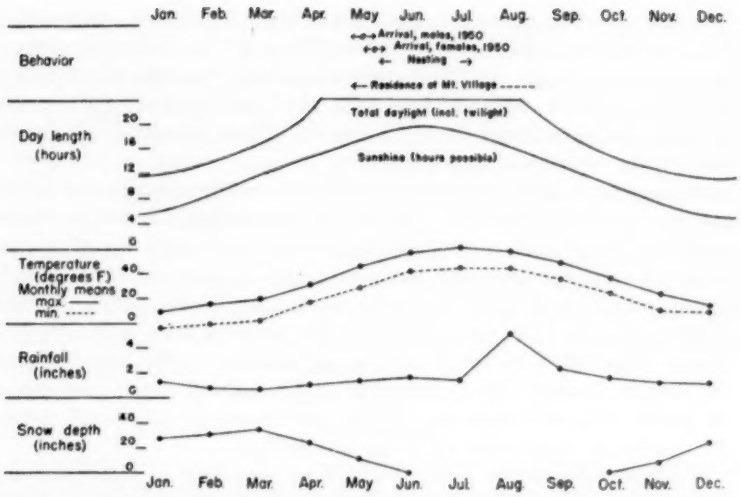


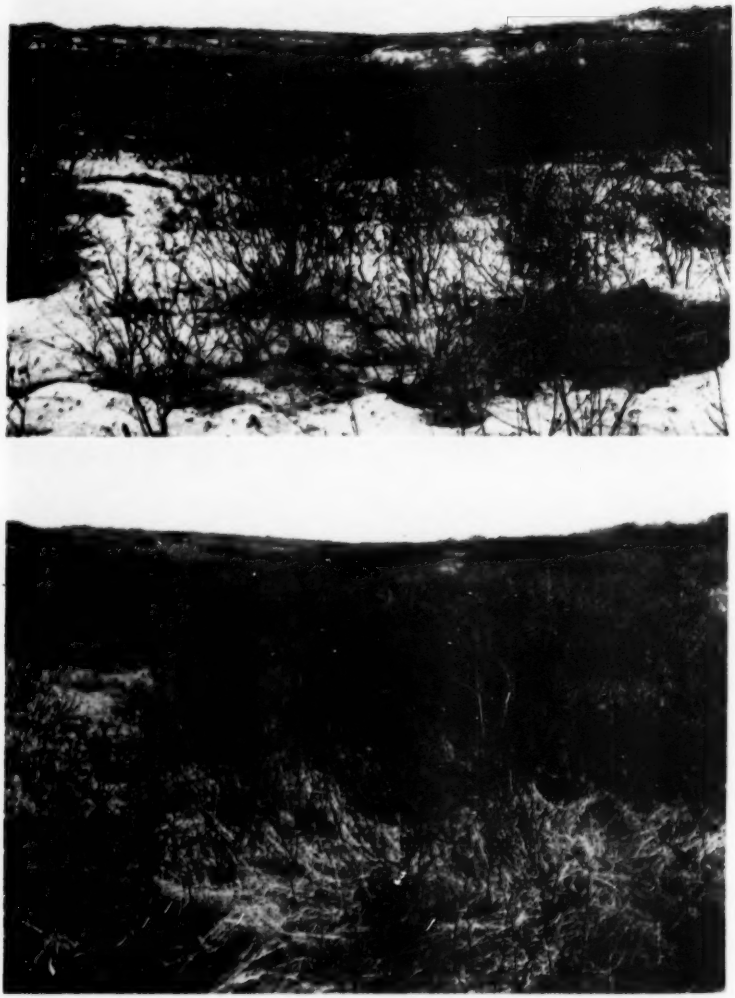
FIGURE 1. The relation of the residence period for Gambel's Sparrows at Mountain Village, Alaska, to the climate. Temperature and rainfall data are based upon averages of 4 to 6 years, and snow depth upon averages of 2 to 3 years.

His earliest record is for May 7, 1943, and his average date for "first Gambel's Sparrow seen" is May 10. His average date for when the species becomes common falls between May 14 and 15.

Correlation with departure from wintering grounds.—The nature of the influx at Mountain Village complements that of departure from the wintering grounds at Davis and Santa Barbara, California. As already stated (Blanchard and Erickson, 1949) it takes almost as long for one flock to disappear from the wintering grounds as it does the whole population. The thinning-out takes place over at least 14 days, which is close to the 19-day interval for the arrival at Mountain Village. Furthermore, just as the males arrived first at Mountain Village, so they get ready to leave the wintering grounds first. At both Davis and Santa Barbara, the earliest members of a given flock to get ready to leave (as judged by the accumulation of fat and progress of the molt) are males. In flocks not depleted by collecting, the last birds to be ready are predominantly females.

Approximate time spent in migration.—Table 1 shows the dates for 1950 for earliest and latest observed departure and arrival, and earliest, latest, and average dates for 21 years and 11 southern California and 3 far northern localities. Between the data for 1950 and the averages for all years and stations there is agreement too close to be accidental.

HABITAT OF GAMBEL'S SPARROW. The "Mountain": change in appearance of the country above Mountain Village, Alaska. (*Upper*) May 4. The earliest males came five days later. (*Lower*) The same spot on June 19, when nesting was in progress.



HABITAT OF GAMBEL'S SPARROW. Vegetation of the same spot. (*Upper*) May 7: the earliest males came two days later. (*Lower*) May 21: the earliest females had already arrived.

The time spent in migration by any one flock may well approximate thirty-five days. In the closely related race, *pugetensis*, there is evidence that populations wintering close to the southern limit of the wintering range breed close to the northern limit of the breeding range (Blanchard, 1942). If this is also true in *gambeli*, then it is at least a cogent possibility that birds wintering in southern California breed as far north as latitude 62° N. The air distance between Santa Barbara and Mountain Village is about 2700 miles, but the route taken by the birds is almost certainly longer. If we assume that birds wintering in southern California fly at least 2700 miles in not more than 35 days, then they would average over 75 miles per day.

TABLE 1

DEPARTURE AND ARRIVAL DATES, *Zonotrichia leucophrys gambeli*

	Earliest departure from so. Calif.	*Earliest arrival on breeding grounds*	*Interval*	*Latest departure*	*Latest arrival*	*Interval*
1. Dates for 1950: three so. Calif. stations and Mt. Village	April 6	May 9	35 days	April 21	May 28	37 days
2. Dates for all years and localities						
a. earliest and latest	March 27	May 1	35 days	May 14	——	——
b. average dates	April 6	May 10	36 days	April 26	——	——

Relation to the climate of the breeding grounds.—The average arrival date for males at Mountain Village falls within the period of most rapid amelioration of most climatic factors. Figure 1 illustrates this for the three- to six-year period for which data are available. By May 10 the total number of hours of daylight has recently reached twenty-four; the curves for temperature and hours of possible sunshine are rising sharply toward their maxima; precipitation is close to the minimum, and unmelted snow is rapidly decreasing. Table 2 relates the arrival dates for four years to the weekly means of daily minimum temperature.

This is not to imply that local weather conditions at time of arrival are critical, although there are numerous records of migrants arriving in the far north which were killed by late storms (Blanchard and Erickson, 1949, data from T. T. McCabe). What is probably of much greater importance is that the birds should arrive early enough

to start nesting as soon as the climate becomes suitable for raising young. The arrival of the males ahead of the females allows for the settlement of territorial matters, and permits the females to avoid some of the risks of late storms. On the more clement breeding-grounds at the Canadian border, females of the Puget Sound Sparrow arrived the same day as the males, but did not begin nesting until one to two weeks later. Females of the Gambel's Sparrow at Mountain Village arrived, on the average, eight days later than the males, but began nesting in two or three days.

TABLE 2

WEEKLY MEANS OF DAILY MINIMUM TEMPERATURES IN DEGREES F., AND ARRIVAL TIME OF GAMBEL'S SPARROWS

Inclusive dates	*Bethel*	*Mountain Village*		
	1946	*1947*	*1948*	*1950*
April 6–12	10.7	12.9	30.4	22.1
April 13–19	8.4	11.7	10.1	15.9
April 20–26	23.7	26.4	14.0	22.9
April 27–May 3	20.6	20.6	19.1	19.1
May 4–10	26.6	31.7	17.7	26.1
May 11–17	29.9	30.9	29.1	28.3
May 18–24	36.0	30.0	32.7	30.3
May 25–31	39.3	39.3	35.7	31.6

Arrival periods (from date first bird seen to date when became common) are bracketed. Data for 1946–1948 from Mr. Henry Kyllingstad.
Dotted bracket for 1950: arrival of females.

Relation to progress of vegetation.—Plates 25 to 28 illustrate the changes in appearance of the country and the vegetation between early May and July. When nesting began, the only vegetation thick enough for concealment was either dead grass recently exposed by the melting snow or dense mats of upland dwarf perennials. That these afforded good protection is evidenced not only by the high percentage of young fledged, but also by the fact that, in spite of years of experience in finding White-crowned Sparrow nests, it took me many hours' intensive search to find each nest.

Physiological condition.—Of eight males known to be newly-arrived, five had mature sperm in the lumens of the seminiferous tubules and two others had mature sperm not yet free in the lumen. The mean testis volume for these eight (140.35 mm.^{3}) was smaller than that of a breeding male collected a month later (251.4 mm.^{3}), and it is probable that even the most advanced testes had not yet reached full breeding condition. The largest ovarian follicles in three newly-arrived females ranged from 1.3 to 2.1 mm. in diameter. Three of the females I watched must have been ready to breed almost as soon

as they arrived, for from five to seven days later they laid their first eggs.

The sharp contrasts in physiological condition between Gambel's Sparrows wintering at Santa Barbara taken on the eve of migration and the new arrivals at Mountain Village have been described (Oakeson, 1953). If we assume that the Mountain Village males began the flight north at about the same physiologic stage as did those wintering in Santa Barbara, and if we take 35 days as the interval spent in flight, then in this period the average body weight decreased by about 14 per cent, the mean liver weight decreased by about 30 per cent, and the mean spleen weight, by about 40 per cent. During the same period the mean testis volume increased over 100-fold. The changes in the females are less marked but are in the same direction.

At first I considered the marked decrease in body, liver, and spleen weights and in subcutaneous fat as evidence of nutritional depletion owing to the rigors of the flight north. Now I am inclined to look upon these changes rather as signs of the end of an endocrine rhythm, genetically based, which runs its course relatively independently of external environmental factors, and which may be partly responsible for the urge to migrate. Three considerations lend weight to such an idea. First, the observations of Laurence Irving and Simon Paneak on the nutritional state of 41 species of birds arriving at Anaktuvuk Pass in the Brooks Range indicate that in general "arriving migrants are fat and in excellent condition." "In some species the weight of the birds at the date of first arrival was greater than it was later during nesting . . . . no detailed method of study has shown that first arrivals exhibit a deficit to denote depletion of their reserves in flight. There is no sign that the northward migration has imposed physiological stress because no strain is visible." (Irving, L. and S. Paneak, 1952). Second, a decrease in body and liver weights, occurs at the comparable stage of the gonad cycle in the permanently resident race, *nuttalli* (Oakeson, unpublished data). This decline cannot be due to any obvious physiological stress, since the birds never migrate, and the decrease occurs before they begin nesting. It could on the other hand be due to an endocrine rhythm basically similar to that in *gambeli*. Third, migrating Gambel's Sparrows in British Columbia, undoubtedly on the last lap of a long flight, may be even fatter than those on the eve of departure from California wintering-grounds (data from T. T. McCabe, *in* Blanchard and Erickson, 1949). The males arriving at Mountain Village, therefore, may be thin and have lower body, liver, and spleen weights than at any other time

of year, not because of any stress during the northward flight but because of a sudden change in nutritional economy, the timing of which may be influenced more by inherent endocrine rhythms and less by direct effects of environmental conditions met with *en route* than has been commonly supposed. We know that the histological condition of the thyroid, for example, is different in Gambel's Sparrows on the eve of migration than in birds newly arrived on the breeding grounds (unpublished data).

Behavior.—Although males arriving at Mountain Village had testes larger and more advanced, histologically, than those of Puget Sound Sparrows arriving at Friday Harbor, no loud singing or noisy conflicts between neighbors took place. The newly-arrived birds were so shy that to get within range of one often took hours of stalking. They flew distances of up to a mile without stopping. Their song was weak. Even after the males had established headquarters where they spent the greater part of each day, they sometimes left the areas for hours. Pursuits were seen, but so were cases of complete tolerance of one male by another. Several factors may have been involved in this weakness of territorial display as compared with the vigorous conflicts at Friday Harbor: the cold and inclement weather at Mountain Village compared with the much warmer and more sunny days at Friday Harbor, the low population density, and the lack of the stimulating effect of a mate. Whatever may have been the reasons, the facts illustrate that the vigor of territorial display is not alone a reliable criterion of testis size and histologic condition.

The few disputes over boundaries or mates that did take place later followed the pattern at Friday Harbor, and when incubation began, the Gambel's Sparrows behaved as do other breeding White-crowned Sparrows, with one exception, that of a male which tried for three days to steal the mate of a neighboring male while his own female was laying and starting to incubate. The facts were as follows.

On May 23, Male 1 acquired a mate. She built one nest, deserted it, and was finishing another when on May 28 copulation occurred. Female 1 must have begun incubation May 31, judging by the date her eggs hatched. Meanwhile the neighbor on the east, Male 7, had acquired a mate. She started her nest May 30. That same evening, Male 1 "attacked" her. (In Nuttall's Sparrows an "attack" occurs when either of a pair is not ready to mate.) Male 7, which until then had been singing regularly but not forcefully, chased Male 1, then began to sing loudly from conspicuous perches, patrolling his area as do males during incubation. The next evening, Female 7

was attacked again by Male 1. Then each time she flew, she was pursued by both males. Finally Male 7 began to chase the intruder, but could not drive him back to his own area. At 9:10 p.m., over one and one-half hours after the dispute had begun that evening, Male 7 began to patrol his territory, which now, owing to his intensified behavior, merited the term in all its connotations, and incorporated into his patrol a high aerial pole, from which he sang loudly. (Since there are no tall trees at Mountain Village the aerial poles near the Trading Post were favorite singing perches.) There followed a "singing contest" between the two males. This lasted until 9:45 p.m., some time after other birds had quieted down for the night. During the contest, Female 7 trilled and postured vigorously but her mate was too preoccupied to pay any attention to her. The next evening, June 1, the performance was repeated, and Male 1 flew at Pair 7 whenever they attempted copulation, preventing the mating not only psychologically but also physically, at least as long as I watched. By the next day the situation had returned to normal: each male sang from his respective territory. Pair 7 must have succeeded in copulating, for the female finished her nest June 1, laid her first egg June 3, and all eggs hatched June 19. This is the only case I have seen in White-crowned Sparrows where one male tried to steal a mate from another male while his own female was laying and incubating.

BREEDING

Relation to the climate.—Figure 1 shows the relation of the period that Gambel's Sparrows are resident at Mountain Village to the annual cycle of climate, based upon averages for several years. Figure 2 shows the timing of the events in the breeding cycle in 1950 and weekly climatological data for that season. Except for rain, the climate is least severe during nesting, yet the weather in 1950 was far from clement, and the year was not considered severe by old-timers. Between the day the first egg was laid and that when the young of Pair 1 were fledged, for example, there occurred a hailstorm with snow flurries, twelve days of rain, six of them consecutive, nine days with winds up to 35 miles per hour as recorded in a relatively protected part of the village, and four nights when the temperature fell to freezing or below. Yet, with the possible exception of one pair, which deserted their first nest, none that I watched lost eggs or young because of bad weather. At the end of the six-day storm, I found one setting female with drops of water on her back, but this was the only case I saw even of slight wetting, so effective in shedding water were the dead grass stems arching over the nests.

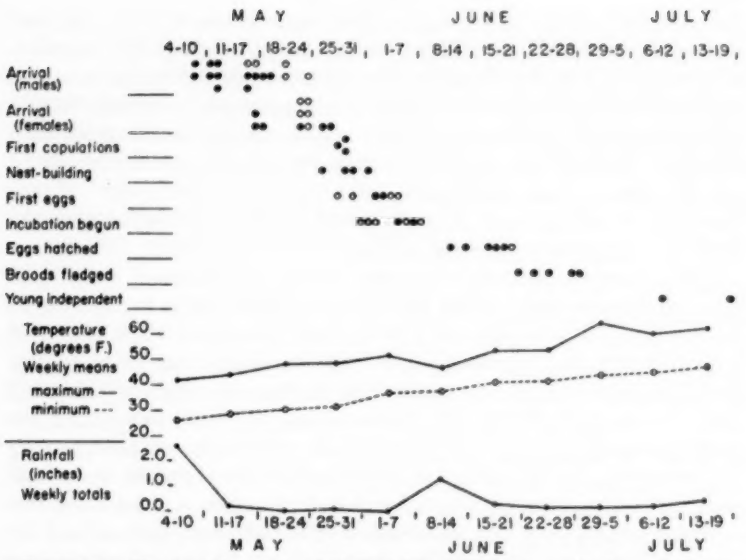


FIGURE 2. The breeding cycle of 1950 at Mountain Village, Alaska, and weekly means of temperature and total precipitation. Solid dot, data based on direct observations. Hollow dot, data calculated from subsequent observations.

Residence at Mountain Village.—The average period of residence for males is probably not less than 12 and not more than 16 weeks, of which less than seven weeks are spent in raising the single brood, and the rest either in preparing to nest or in molting and getting ready for fall migration. The average date of arrival of the earliest males, based on Kyllingstad's records for six years and mine for 1950, is May 10. Departure cannot be defined so narrowly. Kyllingstad (personal communication) says "a few stayed into the first week of September each year." From his banding records for four years, he states: "I believe most of the July (trapped) birds are those produced in the vicinity of Mountain Village. An influx, perhaps from farther north and west, occurs about the second week in August. These are mainly young of the year. Adults are very scarce in this group. Another influx strikes a week or two weeks later and many of the last birds in this wave are adults."

Breeding condition in the male.—The period from first observed copulation (May 28) to the first specimen with small testes (collected July 5) was 38 days in 1950. One male in full breeding condition was taken June 27, and others with small testes were taken July 13 and 19.

Raising the young.—Table 3 shows the duration of intervals within the breeding cycle. For one pair watched daily, the interval from first observed copulation to the day the young were first seen foraging independently was 43 days. For another pair, the interval between first observed nest-building and independence of the young was also 43 days. Pairs which fledged one brood made no attempt to raise a second. One female deserted her first nest, containing one newly hatched young and three eggs, on June 18. The pair moved their headquarters and fledged their young from the second nest July 19. The first egg must therefore have been laid in the second nest a week after the previous nest was deserted.

TABLE 3

DURATION OF BREEDING PHASES AT MOUNTAIN VILLAGE

Interval	*Number*	*Range, in days*	*Average, in days*
First copulation—testis regression	whole population		38
Arrival of female—nest begun	3	3–4	3.3
Nest finished—first egg laid	5	0–3	1.2
Earliest first egg—latest first egg	5		8
Young hatched—young fledged	13	8–10	9.0
Fledging—independence of young	3	(minimum = 19)	

Clutch size.—The average for six clutches was 4.66 eggs. Four or five eggs were laid in each clutch.

Nestling development.—The growth, progress in feathering, behavior, and general competence of the *gambeli* nestlings was so closely similar to that described for *nuttalli* nestlings (Blanchard, 1941) that it need not be reviewed here. In table 3, the figure of 9.0 days for the average nestling period was obtained by averaging the periods for individuals, rather than broods, since not all young in the same nest were hatched, or fledged, the same day. The brood I weighed daily is omitted from the average. They jumped out of the nest from fright when four were eight, and one only seven, days old. Of thirteen nestlings which left the nest without any obvious cause for fright, one left when eight days old, i.e., on the eighth day after the day hatched, eleven young left when nine days old, and one, when ten days old. Comparable treatment of data for Berkeley Nuttall's Sparrows and Friday Harbor Puget Sound Sparrows (table 4) indicates that the average nestling periods of the three races, while closely similar, are probably not identical. Karplus (1952) watched a brood of Robins at Umiat (lat. 69° 23′ N.) which left the nest nine days after hatching. Data for 85 Robin broods in the "northern United States"

give a much longer average nestling period (13.2) although there is one possibly abnormal record for nine days. No such marked shortening of the average nestling period appears to occur in *Zonotrichia leucophrys* between latitudes 37° 48′ N. and 62° 07′ N., a latitudinal change not much less than that between the two regions involved in the comparison of Robin nestling periods.

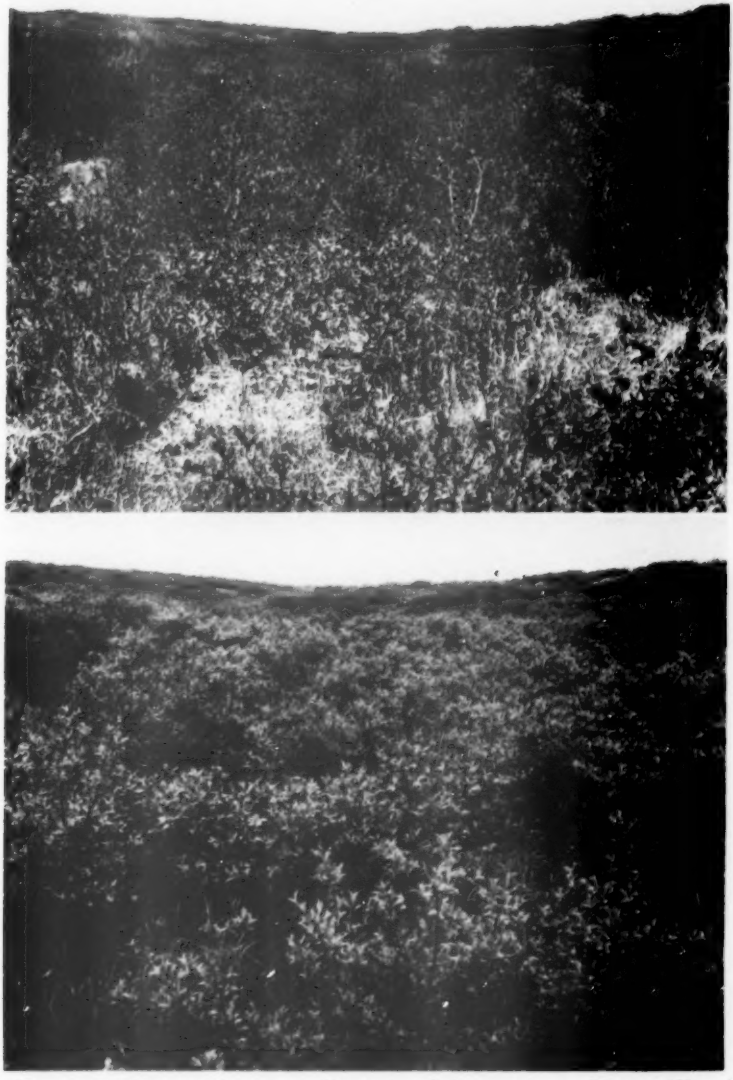
TABLE 4

NESTLING PERIODS FOR THREE RACES *of Zonotrichia leucophrys*

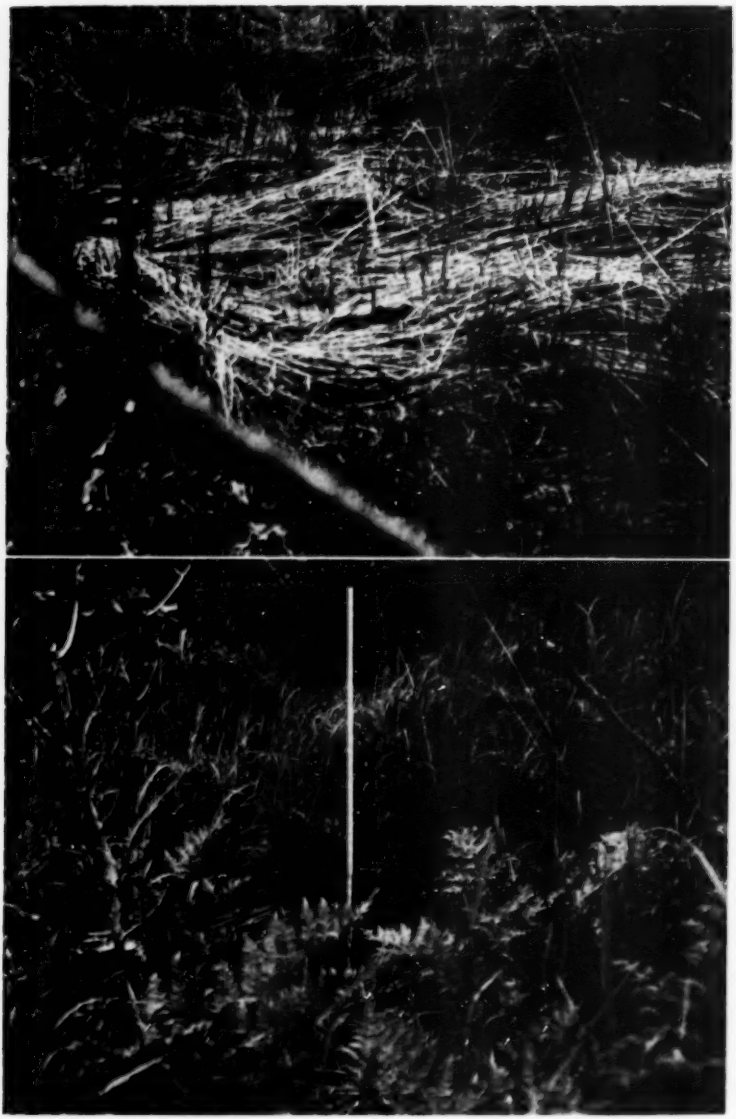
Race	*Population*	*Number of nestlings*	*Range of nestling period, days*	*Average nestling period, days*
nuttalli	Berkeley, California (37° 48′ N.)	23	9–11	10.08
pugetensis	Friday Harbor, Washington (48° 30′ N.)	26	8–11	9.61
gambeli	Mountain Village, Alaska (62° 07′ N.)	13	8–10	9.00

Comparison with pugetensis.—The compression of the breeding cycle of Friday Harbor *pugetensis* as compared with Berkeley *nuttalli* has been analyzed in detail (Blanchard, 1941). The Gambel's Sparrow cycle at Mountain Village (38 days) was compressed to less than one-third that of Berkeley *nuttalli* (116 days) and to less than one-half that of Friday Harbor *pugetensis* (90 days). The greater part of the time saved lay in the fledging of only one brood, but compression of several other intervals was necessary in order to make fullest use of the short time between arrival and gonad regression. Males of the Gambel's Sparrow arrived with testes approaching full breeding condition, and, therefore, could presumably mate with the females as soon as the latter arrived. Before their mates came, they had established the rudiments of territories so no time was lost after the females' arrival either in establishing nesting areas or in achieving at least physiological readiness to mate. The females were ready to mate and begin work on the nest within a few days after arrival. Table 5 gives comparative data for *pugetensis* and *gambeli* for median dates of arrival, first copulations, and first eggs. The time spent in building the nest may also be shortened in *gambeli*. Four females spent between 2 and 4 days in building (average of 2.7 days) while one Puget Sound female at Friday Harbor spent 7 to 8 days on her first nest. Comparable figures for *nuttalli* are from 7 to 9 days for five nests found the day they were begun.

Percentage of young successfully fledged.—Of eight broods watched, six were successfully fledged, and at least one of the nestlings in each of the other two is known to have been fledged. The data of course



HABITAT OF GAMBEL'S SPARROW. Vegetation of the same spot as Plate 26 (*Upper*) June 19: nesting in progress. (*Lower*) July 2: most young had been fledged.



HABITAT OF GAMBEL'S SPARROW. Vegetational changes at nest-site of female 7. (*Upper*) June 4: two eggs had been laid. (*Lower*) July 2: the young had been fledged four days before.

TABLE 5

DURATION OF INTERVALS IN NESTING CYCLE
Zonotrichia leucophrys pugetensis AND *Z. l. gambeli*

	pugetensis		*gambeli*	
Interval	*Median dates*	*Duration, days*	*Median dates*	*Duration, days*
From arrival of males to arrival of females	April 10 for both sexes	0	May 16–May 24	8
From arrival of female to first copulation	April 10–21	11	May 24–May 28–29	4–5
From first copulation to first egg	April 21–29	8	May 28–29–June 2	4–5
From arrival of female to first egg laid	April 10–29	19	May 24–June 2	9

represent only one season, and one of low numbers at that. Yet they do at least raise the question of whether Mountain Village may not be substantially safer for raising young than more southern localities. The percentage of Nuttall's Sparrow broods successfully fledged during the four years I watched the nesting cycle at Berkeley was only 12 out of 30, or 40 per cent. Comparable figures for Friday Harbor Puget Sound Sparrows for 1936 were 19 out of 32, or 59 per cent. Certainly the kinds and numbers of natural enemies are greater in the south. At Berkeley, jays, cats, and snakes are common. At Friday Harbor, crows appeared to be chiefly to blame for the destruction of the nests I watched. In both cases my daily trips to the nests undoubtedly increased the hazards from crows and jays. The scarcity of natural enemies at Mountain Village has already been mentioned.

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SUMMARY

Data for this paper include analysis of seasonal changes in climate and vegetation at Mountain Village, Alaska (lat. 62° 07′ N.); anatomical analysis of Gambel's Sparrows collected on the day of, or shortly after, arrival at Mountain Village; daily observation of nine nesting pairs followed throughout the breeding season of 1950; and departure and arrival dates for a period covering 21 years from 11 southern California banding stations and 3 far northern localities.

Arrival of Gambel's Sparrows at Mountain Village in 1950 covered at least 19 days and coincided with the period of most rapid amelioration of most climatic factors. Males came 8 days earlier, on the average, than did females. Although their testes were close to breeding condition, territorial display was weak. Their body weight, liver and spleen weights, and subcutaneous fat averaged less than that of specimens taken at any other time of year. The time spent by far northern breeding populations in spring migration is estimated to be about 35 to 37 days.

The residence period at Mountain Village for males is between 12 and 16 weeks, of which about 6 weeks are spent in raising the single brood. For two pairs, 43 days elapsed between first observed copulation, or first observed nest-building, and the day the young were first seen foraging independently. Phases which were compressed even more in *gambeli* than in Friday Harbor *pugetensis* were the period from arrival of females to first copulation and that from first copulation to laying of the first egg. The average nestling period appears to decrease slightly with latitude (10.08 days for Berkeley *nuttalli*,

9.61 days for Friday Harbor *pugetensis*, and 9.00 days for Mountain Village *gambeli*).

The high percentage of broods fledged suggests that Mountain Village may be safer for White-crowned Sparrow young than Berkeley or Friday Harbor, but more data are needed to establish this. The scarcity of natural enemies at Mountain Village in 1950 was striking.

In the light of (a) the observations of Irving and Paneak on the nutritional state of 41 species of birds arriving at Anaktuvuk Pass, (b) those of McCabe on the large amount of fat possessed by migrating Gambel's Sparrows in British Columbia and (c) those of the author on seasonal cycles in liver and spleen weights in the non-migratory Nuttall's Sparrows, it is tentatively suggested that males arriving at Mountain Village with low liver and spleen weights and little fat may have undergone a sudden change in nutritional economy, the timing of which is influenced more by inherent endocrine rhythms and less by direct effects of environmental conditions met with during migration than has commonly been supposed.

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University of California, Santa Barbara College, Goleta, California, December 4, 1953.

THE REPRODUCTIVE CYCLE OF AMERICAN COOTS IN CALIFORNIA

BY GORDON W. GULLION

INTRODUCTION

THE American Coot (*Fulica americana*) possesses some peculiarities in breeding behavior that have not been adequately described. During the period from April, 1949, to August, 1950, I made a study of the breeding behavior of this species, some aspects of which have been published previously (Gullion, 1950; 1951*a*, *b*; 1952*a*, *b*, *c*; 1953*a*, *b*). The material presented in this paper constitutes two chapters from a thesis submitted in partial satisfaction of the requirements for the degree of Master of Arts in Zoology in the Graduate Division of the University of California. This completes the publication of the major contributions from the thesis.

This paper discusses the breeding behavior of the coot, in as nearly a chronological order as convenience allows, commencing with pair formation and following through to completion of the nesting cycle and the growth of the young until they are independent and leave their home territory. Two recent papers have dealt in detail with the necessary accessories to actual nesting, *i.e.*, the displays that bring two coots together to form the pair and then the displays and calls that enable the newly formed pair to secure and maintain a territory (Gullion, 1952*b*). The secured territory in turn permits the pair, with a minimum of disturbance, to proceed with the displays and calls which bring both birds into the synchronized physiological condition necessary if fertile matings are to occur and the breeding cycle is to be successfully completed (Gullion, 1953*b*).

The study was conducted in the San Francisco Bay area of western California. Most of the data reported here are the result of observations on five pairs of coots inhabiting two small lakes—Lake Temescal in northeastern Oakland, Alameda County, and Jewel Lake, in Tilden Regional Park, Contra Costa County (for a more complete discussion and maps of these areas see Gullion, 1953*b*).

Many of the coots discussed in this paper were marked with a plastic marker while others were identified by the shape and size of the shield. Sex determination was made mostly on the basis of voice differences, while age determination was made largely by leg color. These techniques have been discussed in previous publications.

The account of development is based upon the average growth of 43 young coots in the eleven broods produced by the five pairs

during the two breeding seasons studied. Young coots were nail-clipped as they hatched. This was found to cause deformation of the nail which served to distinguish the birds until they were 60 to 90 days old and large enough to carry an aluminum leg band. Marking at the time of hatching permitted a close check on the rate of growth of young coots as they were recaptured from time to time.

PAIRING

American Coots are probably exclusively monogamous although various workers have made statements to the contrary (*cf.* Dawson, 1923: 1560; Walker, 1932: 322). In resident pairs with suitable territory the pair bond probably lasts for the life of the respective birds. The territorial behavior of several birds at Lake Merritt, in downtown Oakland, through the winter of 1949–50 suggests that at least some migrant coots may remain paired through the period that they are away from their breeding territory.

Actual pair formation follows a long period of courtship. Prominent among courtship activities are the billing, bowing, and nibbling displays during which two birds touch bills, one then arches its neck and bows its head while the other works its bill through the bowing coot's head, neck, breast, and back feathers (Gullion, 1952*b:* 89). Among winter flocks (as observed among captive coots and at Lake Temescal) these three activities were carried on indiscriminately as regards sex. Generally males initiated the routine, and during the fall and winter another male became the submissive object of display as readily as a female. In fact, the display sequence was observed most frequently between males. Females initiated billing, bowing, and nibbling with males on several occasions, but never with another female.

The readiness with which strange birds participated in bowing and nibbling during the winter was surprising. A bird taken from Lake Merritt and released at Aquatic Park, on the Berkeley waterfront, on November 18, 1949, was bowing with another coot on the following day. Another bird taken from Lake Merritt on the same day and released on Jewel Lake on December 2 was bowing with a resident coot about 12 hours later.

Billing was the initial contact between two coots. If the approached coot billed readily, the other bird attempted to nibble, and if the approached bird was receptive to nibbling, it bowed. With the advancing spring season males submitted to this display less readily and commenced pecking the advancing bird, whereas females began bowing at the approach of another coot. If the approaching coot

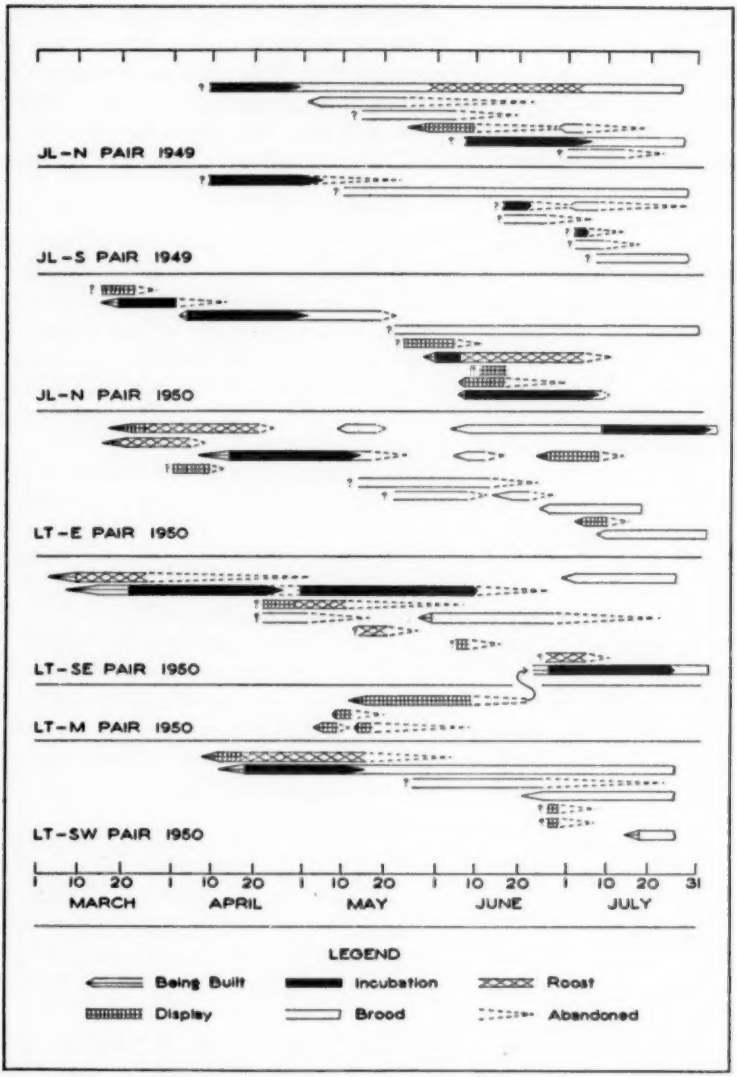


FIGURE 1. The building sequence, use, re-use, and durability of coot nesting structures at Jewel Lake (JL) and Lake Temescal (LT). Each horizontal bar represents a single site.

was another female, she usually pecked the bowing bird, but if the approaching coot was a male, he nibbled on the head and neck of the bowing female and tried to bill with her.

Certain males began advancing to and nibbling upon certain females more frequently, and the beginning of the pair bond became evident. As this behavior became more restricted to members of a pair, the female, though remaining submissive, frequently nibbled on the male when his ardor lagged, stimulating him to further activity. At this stage in the pair formation the female occasionally moved close to the male of her choice and bowed, stimulating him to nibble. Dabbling in the water often accompanied bowing and nibbling behavior, the bowing bird doing the dabbling.

Once the pair bond was fairly well cemented, the pair, with the female leading, began seeking a territory and a nesting site. The success or failure of the pair to secure a territory at this time is the final hurdle in the formation of a permanent pair bond. After territory was secured a *swimming arch* became a frequent display of the female. In this display the female swam immediately ahead of her mate with her neck rigidly arched and her tail broadly fanned to exhibit her white under tail coverts.

NEST STRUCTURES

The American Coot is a prolific builder of structures associated with nesting (figure 1). These structures consist of *display platforms*, *egg nests*, and *brood nests*. It was found that three pairs of coots laying two or more clutches of eggs in a season built nine structures each, while the one pair that laid only one clutch of eggs built seven structures.

Display platforms.—These structures are usually the first to be built in the spring. They are composed of coarse cat-tail stems and leaves and are built upon a foundation such as a floating board or stick (plate 29A) or a heap of broken-down cat-tails (plate 29B). The platform seldom rises more than one inch above the water and is about a foot in diameter. It is usually thoroughly water-soaked, and after the copulation period it is allowed to disintegrate. The non-incubating bird may use the display platform as a roosting site until it disintegrates, and if it is so used, it becomes littered with feces.

Egg nests.—While the display platform is in use the egg nest is built. Often more than one such structure is built before one is finally selected. The remaining nests are either allowed to disintegrate or are put into service as night roosts.

The egg nest, like the display platform, starts on a foundation of some sort with the first materials consisting of the coarse stems of cat-tails. As the nest develops, finer materials are added. A ramp is built on one side of the nest and is worked into the nest structure (plate 29C). This permits birds to enter and leave without tearing the sides of the nest down. Usually the ramp is composed of coarse stems laid lengthwise on the side of the nest.

The egg nest is kept clean of feces, and the cup is composed of fine, dry leaves. The average nest has a rim four to six inches above the water, an overall diameter of about 12 inches, with a ramp about 12 to 15 inches long. The egg cup is usually about one inch deep and six inches in diameter (plate 29D).

Since the egg nest is actually an elaborate raft, it must be added to constantly to keep it from settling below the surface. Materials added to the top of the nest may settle to the water-line in four days, being covered in the meantime with new materials. This results in the accumulation of a great pile of decaying plant material under the nest.

Egg nests may be either new structures or nests used earlier for other purposes. In one instance at Lake Temescal the second egg nest of one pair was built upon a disintegrating display platform of a second pair unable to defend their selected site. The second clutch of another pair was laid in a relined brood nest which had been used by this pair as recently as seven days previously.

Brood nests.—When the eggs hatch, a new nest is usually constructed. This nest, used for brooding young, is like the egg nest but larger, and measures as much as 18 inches across and eight inches high. A cup is frequently lacking, or if present in the original construction, it is soon obscured by the addition of fresh material. A brood nest is readily distinguishable from an egg nest by the wet materials worked into the final lining and the presence of feces in and about the nest (plate 29E). Egg nests are frequently converted to brood nests (plate 29F).

Materials.—The materials used in nest construction were usually those most readily available. The statement made by Grinnell *et al.* (1918: 317) that "the usual material . . . is the green stems of tules or sedges" and that "the drying out of the fresh stems during incubation has led to the popular idea that the birds use dry stalks" was not at all true in my study areas.

Structures built early in the season were composed almost exclusively of dead material since green material was not available.

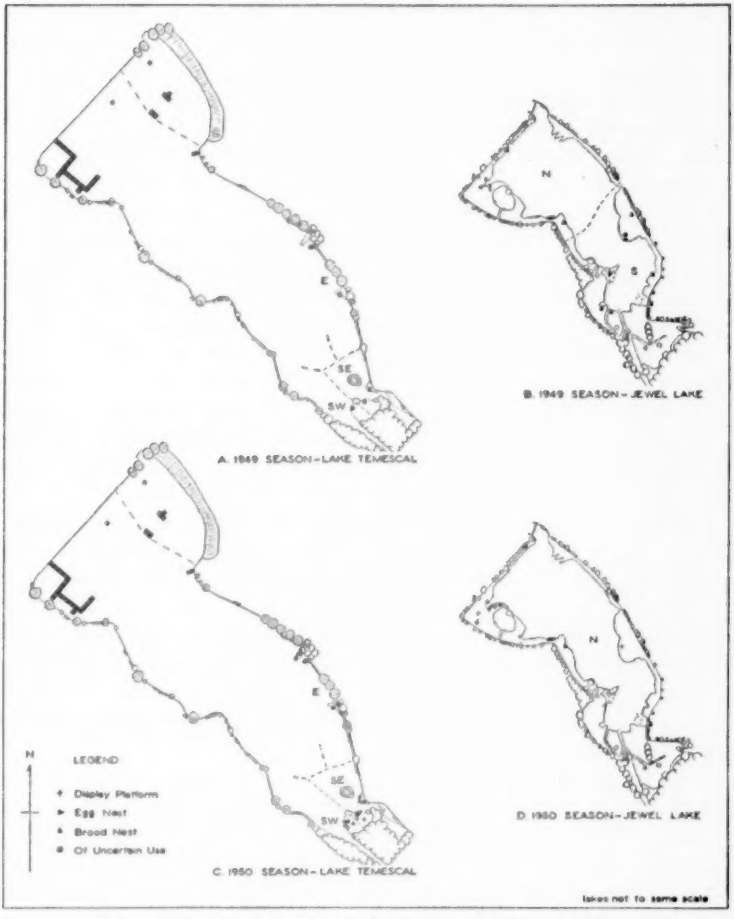


FIGURE 2. Locations of nesting structures, 1949 and 1950.

Later, when coots were feeding exclusively upon the bases of young cat-tail leaves and many loose leaves were floating in the nesting areas, a great deal of greenery appeared in the nest construction. Still later, dried material again predominated as other food became available and the coots ceased feeding upon cat-tail shoots. On several occasions green leaves were pulled down from surrounding cat-tail plants and worked into the nest.

Frequently nests built among broad-leaved cat-tails (*Typha latifolia*)

were composed almost entirely of parts from the narrow-leaved species (*Typha angustifolia*) and vice versa, indicating that materials were secured some distance from the nests. Provost (1947) found evidence that coots in Iowa favored the more buoyant bulrushes (*Scirpus* sp.) and bur-reeds (*Sparganium eurycarpum*) over cat-tail materials for nests. These plants were not available in my study areas.

Though cat-tails were most readily available at Lake Temescal, other materials were used from time to time. One pair used dry willow (*Salix* sp.) leaves in its nest. This and another pair frequently used green stems of the sago-pondweed (*Potamogeton pectinatus*) around the rim of their nests, while the third pair on the lake resorted to small sticks to build up a particularly large brood nest (plate 30E).

Location.—All structures studied in this area were located close to open water (figure 2). Four feet was the maximum distance from open water and two or three feet was the more frequent distance (plate 30A). On three occasions, trails made through the cat-tails by repeated wading on my part, sufficed as open water and nests were built along them.

Certain sites seemed to be favored. For example, the third egg nest of the N pair at Jewel Lake in 1950 was built on the identical site as the second nest of the N pair in 1949 (pair designations refer to territorial pairs discussed in detail elsewhere—see Gullion, 1953*b*: 170–173). It even had its ramp facing in the same direction. Two structures of the E pair at Lake Temescal in 1950 were built on the sites of two of its 1949 structures. One of these, the P16 site (plate 30B), was rebuilt twice before it finally received eggs (figure 1; LT-E pair 1950, first horizontal bar).

Discussion.—Overhead structures were not built by any coots, but nests were invariably located where overhead cover was already present. Observations were infrequent on construction, but they indicated that the female did a large part and probably the major share of this task. However, among a flock of captive birds, held on the Berkeley Campus of the University of California, it was evident that nest building was not entirely the duty of the female since males frequently carried materials to their mates.

Wetmore (1920: 396) believed the male took no part in nest construction, but Walker (1932: 323) was probably more nearly correct when he said, "the female soon took her post on the nest and the male brought reeds to her, some of which she wove into the nest."

The short life of these nests is remarkable (figure 1). The fourth egg nest of the N pair on Jewel Lake in 1950 completely disintegrated within 48 hours of the end of incubation, and many other nests were

little more than accumulations of rotting cat-tail leaves ten days after incubation ended. In direct contrast, a Ruddy Duck (*Oxyura jamaicensis*) made a woven nest of green cat-tail leaves close to a coot nest. Without further additions, this nest lasted to hatch a clutch of duck eggs after 24 days incubation. Following that, coots took it over as a night roost, and it finally collapsed 18 days after the duck clutch had hatched.

Sooter (1942: 127) in an Iowa study, found all of his nests in emergent vegetation with "Narrow lanes of water . . . between the nests and wide channels or large pools." Most other authors likewise record nests as being in emergent vegetation on the water surface. The few records of nests on dry land, in trees or elsewhere, suggest nests built during abnormal water conditions.

COPULATION

Copulation was observed on several occasions and always followed the same general pattern. It is best illustrated by the act observed on April 8, 1950, at Lake Temescal. Both birds of the E pair were swimming and feeding together just north of their platform area (see plate 29B). After a moment of chasing, the female moved into the cat-tails with the male close behind. As she crossed the platform she remained silent but arched and slapped the platform with one foot. Still arched, she settled down on the platform, in a squat with her head under the water. The male mounted her and started giving a closely spaced *kurk, kurk, kurk*. He did not grasp her head but gently mounted squarely on her back, his head lowered and using his wings for balance. She now raised her head out of the water, he reared back, apparently hanging onto her back with his claws as copulation took place. The actual intromission took no longer than two seconds, after which he dismounted and swam away. The hen then stood up and preened for several minutes before leaving.

A copulation observed June 13, 1950, at Jewel Lake differed only in the early stages. On this occasion the male moved to the vicinity of the female from another part of the pond, fed close to her for a moment, and then moved over to her, giving a low cough with his bill open and emitting a barely audible sound. Under his close pursuit she moved away in a *brace* (Gullion, 1952*b*: 89), going directly to a platform at the edge of the cat-tails. Here she assumed the *squat arch* and copulation proceeded as above. The elapsed time between the male's joining the female and resuming normal feeding following copulation was three minutes. The usual notes and displays were involved, *i.e.*, the "coughing" of the male, the chase with

the female bracing, the arch, and post-copulatory displacement-preening. There was, however, no preliminary courtship play, vocal or visual. This has been the pattern of each coot copulation I have observed.

Sooter (1941: 38) agrees that there is no preliminary display but believed that the male grasped the head of the female and that the female gave "some shrill cries . . . during the act." He noted displacement fluffing of the feathers following copulation.

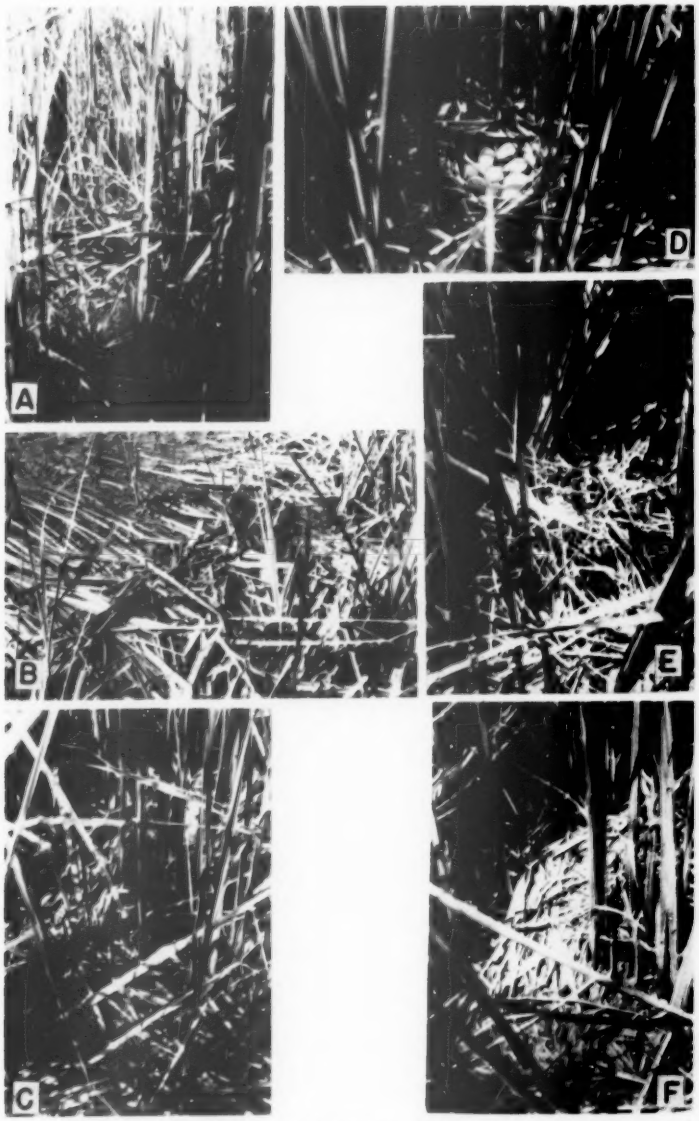
On one occasion an incident was observed that may have been underwater copulation. The M pair at Lake Temescal, without secure territory, was feeding leisurely when the male started chasing the female, giving a low cough as he pursued her. She dived and he followed immediately. When they surfaced about 75 feet away, the male moved off in a brace while the female remained in place, doing displacement-preening. The sequence strongly suggests underwater copulation, but I could not be certain that it did occur. The underwater copulation recorded by several authors may have been misinterpreted fighting (*cf.* Dawson, 1923: 1560; Townsend, 1925: 6).

Copulation after the clutch is complete is probably unusual but was recorded in the SE pair at Lake Temescal in 1950. During this period the M female was established deep in the SE area while the M male was unable to remain close to her. The resulting platform activity of the M female apparently kept the SE male so stimulated that, although he refused to respond physically to her displays, he did chase and try to copulate with his own mate nearly every time they changed incubation shifts, which was hourly. Several times mounting was observed and intromission may have occurred. The seductive behavior on the part of the M female, though evidently disturbing the composure of the SE male, did not do so sufficiently to cause him to be unfaithful or to upset his previous commitments to the regimen of incubation and other family duties.

Egg Deposition

Rate.—It is generally agreed among all who have studied the nesting of the American Coot that one egg is deposited each day until the clutch is complete. In eight nests observed in this study, this was the case.

On the other hand the Lake Temescal SE female delayed 24 hours during the laying of some of the early eggs of her first 1950 set. A 48-hour gap occurred between the deposition of the first and second eggs, since the nest contained two new eggs the third morning, indicating that the second egg was held over to be laid the same day as the third



COOT BREEDING STRUCTURES. *A*. Floating display platform built on a stick. *B*. Display platform on broken-down cat-tails. *C*. Ramp on egg nest. *D*. Egg nest built on foundation of bent-over cat-tails (same nest as *C*.). *E*. Brood nest. *F*. Egg nest converted for brooding (same nest as *C*. and *D*.).

COOT NESTING SITES AND CHICKS. *A*. Minimum nesting cover (site of Q nest of the LT-E pair, 1950). *B*. The P16 nest site of the LT-E pair. *C*. Head of a newly hatched coot. *D*. A day-old coot.

egg. A similar gap of at least 48 hours occurred between the laying of the ninth and tenth eggs in the first 1950 nest of the Jewel Lake N pair. Sooter (1941: 41) records two nests with two eggs appearing in one day but believed one was laid by a second female.

Time.—Early in the period of egg deposition the eggs are laid shortly after midnight, apparently about 12:45 a.m. Checks on the third nest of the SE pair at Lake Temescal on June 27–28, 1950, showed an egg deposited between 10 p.m. and 2:15 a.m.; on June 29, a new egg, very much warmer than its nest-mates, was present at 1 a.m.; on June 29–30, a new egg was laid between 11:35 p.m. and 12:50 a.m.; on July 2, the sixth egg was deposited between 12:58 and 1:48 a.m.; and on July 4, the eighth and last egg was deposited after 2 a.m.

The last three or four eggs are probably deposited about 4 or 5 a.m. The first four nights, the female was on the nest each time it was visited, but on July 2 and 4 the male was incubating. Normally he would do so all night, with the female relieving him in the early dawn, and then presumably laying that night's egg. On July 2, however, the male was purposely chased to open water in order to be sure that it was he that had been flushed from the nest. The male did not return to incubate, but the female did and laid the sixth egg at what was probably an unusually early hour. On July 4, the incubating male was not disturbed, and he was still incubating when last checked at 2 a.m. The eighth egg was laid later that morning. Similar data concerning dawn laying of the last eggs in a clutch were obtained from an earlier nest of this pair.

Sooter (1941: 41) records five nests in which eggs were deposited between sunset and 3 a.m. However, he does not indicate the size of the clutches at the time.

Clutch size.—Eight early season nests at Jewel Lake and Lake Temescal contained an average of 9.0 eggs per clutch, ranging from seven to ten. Five late clutches, all second nestings, contained an average of 6.4 eggs, ranging from four to eight eggs per clutch. Sooter (1941: 57), in Iowa, found an average of 8.6 eggs in 224 clutches completed by June 23, 1937, and an average of 6.03 eggs in 1936 and 6.63 eggs in 1937 for clutches completed after June 23. Later, Provost (1947) found an average of 8.8 eggs in early nests in the same general area worked by Sooter. In other words, early season clutches and first clutches average two eggs more than second nestings and late season clutches.

Dump nests.—The use of dump nests by coots or the practice of dropping eggs in the nests of other species seems to be rare or absent. In the literature there are many instances of duck eggs appearing in coot nests but not of coot eggs appearing in duck nests.

Egg shape and size.—The typical coot egg has a slightly roughened texture and a buff ground color with fine purplish-brown spots evenly distributed over the surface. Its shape is what Romanoff and Romanoff (1949: 60) call "conical," though it may vary to "biconical." The American Coot egg seems to be typical for the genus *Fulica* and more or less so for the family Rallidae. Among the genera whose eggs are known, only the Oriental genus *Rallina* with its coarse, chalky eggs and the African genus *Sarothrura* with unspotted white eggs differ from the rest of the family in this respect.

Considering the possibility that small egg size and the consequent reduction in yolk available for the development of the embryo might be correlated with hatching and fledging success, I measured most of the eggs in the 1950 clutches at both lakes.

The average measurements for 49 eggs from nine nests was 49.0 by 33.5 mm., exactly the same average given by Bent (1926: 361). However, there was considerable variation in the size and shape of eggs laid by the different females, as shown in table 1.

TABLE 1
EGG SIZES

Season	*Female*	*Clutch*	*No.*	*Average Size Millimeters*	*No.*	*Average Volume Milliliters*
1949	JL-S	first	1	49.5 × 34.1	1	26.0
1950	JL-N	first	4	47.0 × 31.3	4	21.5
1950	JL-N	second	1	47.1 × 31.7	1	23.2
1950	JL-N	fourth	7	47.1 × 31.7	—	—
1950	JL-N	fifth	2	51.2 × 32.9	2	29.3
1950	LT-E	first	4	50.1 × 34.4	—	—
1950	LT-E	second	4	49.8 × 33.7	—	—
1950	LT-SE	second	10	49.5 × 35.1	5	30.2
1950	LT-SE	third	8	50.5 × 34.8	1	32.5
1950	LT-SW	first	10	50.6 × 34.3	1	27.0

Recovered eggs or shells from several nests were measured for volume by water displacement (table 1). Interestingly, in 1950 the Jewel Lake N female, laying the smallest eggs, had 100 per cent survival of young hatched from five eggs out of a clutch of seven, while the Lake Temescal SE female, laying the largest eggs, hatched only five out of three consecutive clutches totalling 25 eggs, and only one young survived. The Jewel Lake S pair fledged seven out of eight young hatched in 1949, while in 1950 the Lake Temescal E and SW pairs, with slightly larger eggs, each hatched seven eggs, but only fledged one and three immatures respectively. However, small boys throwing stones may have affected the survival of the Lake Temescal birds.

A possible explanation of this inverse correlation might lie in the ages of the adults. The mother of the highly successful 1950 N broods at Jewel Lake was a yearling. Her mate in 1950 was her father, she being a member of his second brood in 1949. Her first eggs were all small, "pullet" sized, compared with the eggs laid by the other females. However, the eggs from her fifth clutch of the season were almost the normal size. On the other hand, at least two of the three 1950 pairs at Lake Temescal were at least two years old and may have been much older.

Egg weights.—Eggs from several nests were weighed at intervals. Four eggs from the first nest of the 1949 S pair at Jewel Lake, weighed 28.9, 26.4, 28.2, and 28.1 grams on May 3. Two days later, in the same order, they weighed 28.6, 26.2, 27.0, and 27.7 grams; the first two were addled and the last two were in the process of hatching. (The wet chick, ten minutes after hatching from the third egg in this series weighed 22.4 grams—table 2). Four fresh eggs from this pair's third 1949 clutch, laid in July, ranged from 29.4 to 31.8 grams. One pipped egg of the 1949 Jewel Lake N pair's second clutch weighed 24.9 grams.

In 1950, seven unincubated eggs of the Jewel Lake N pair's first clutch ranged from 25.6 to 27.0 grams, averaging 26.1 grams. At Lake Temescal in 1950, weights were taken on the first clutch of the SE pair. Three of these eggs on the first day of incubation weighed 33.2, 31.8, and 32.8 grams, while ten days later these same eggs weighed 32.2, 30.7, and 31.7 grams. The last egg, intermediate in weight, was the only fertile egg in the clutch.

INCUBATION

Commencement of incubation.—The incubation of early season clutches may start with the second egg or not until the clutch is complete. Once started, it continues without interruption until hatching occurs. In two Lake Temescal nests in 1950 the two oldest eggs were first pipped within a few hours of each other, while the remainder were pipped at one-day intervals, this indicating that incubation began with deposition of the second egg.

In 1950 the first clutch of the Lake Temescal SE pair and the first clutch of the Jewel Lake N pair were not incubated until the last egg was laid.

In second nestings at Jewel Lake in 1949 and 1950, all eggs hatched at one day intervals, suggesting that incubation began with the first egg, while incubation in a second nesting at Lake Temescal in 1950 is known to have begun with the first egg.

While Rockwell (1912: 121) believed that incubation in the coot normally does not begin until the set is complete, the majority of other workers report findings similar to mine. Sooter (1941: 42) found that commencement of incubation was delayed in the earliest nests and that hatching of the first eggs was delayed accordingly. Provost (1947: 498) states, "in early nests at least, incubation begins anytime between the laying of the first and last egg in a clutch, and it is very likely erratic and discontinuous where it occurs during the egg laying period." Since Provost makes the possible mistake of assuming a 21-day incubation period, which may be incorrect, he may be likewise mistaken in believing that incubation is "erratic and discontinuous . . . during the egg laying period." Provost, perhaps, attributed the delayed hatching of eggs to the discontinuous incubation rather than to the 23 to 25 day incubation period.

The practice of starting incubation with the laying of the first egg, as occurs in the aquatic Rallidae, is a curious behaviorism and does not seem to be general among birds. It is not true of Rallidae that nest in dry locations. In searching through the literature I have found this practice to be most common among those rails building large bulky nests on the water and especially among those forms breeding in tropical areas.

Several times I have torn recently abandoned coot nests apart and each time I was surprised at the heat generated by the decay of the moist plant material in the center of those nests. The question arises as to whether the combination of heat from the "compost pile" under the eggs and the warm air above the eggs is sufficient to initiate embryonic development in the eggs. If that is so, then after one or two days the embryo would develop to such a degree that night chilling through lack of incubation would kill the embryos and result in a number of addled eggs in the clutch. Perhaps coots developed the practice of commencing incubation with the first or second egg so that the eggs do not have a chance to chill, once embryonic development has begun.

Sharing of incubation.—Reviewing the subject of coot incubation, Wetmore (1920: 396) believed that the male took no part in incubation whereas Bent (1926: 361) stated that "it is shared by both sexes and the male often stands guard while his mate is sitting." Sooter (1941: 42) obtained evidence that incubation is shared by both sexes but gave no further information.

After a series of observations on nests at both study lakes during 1950, it became evident that both sexes share in the task of incubation

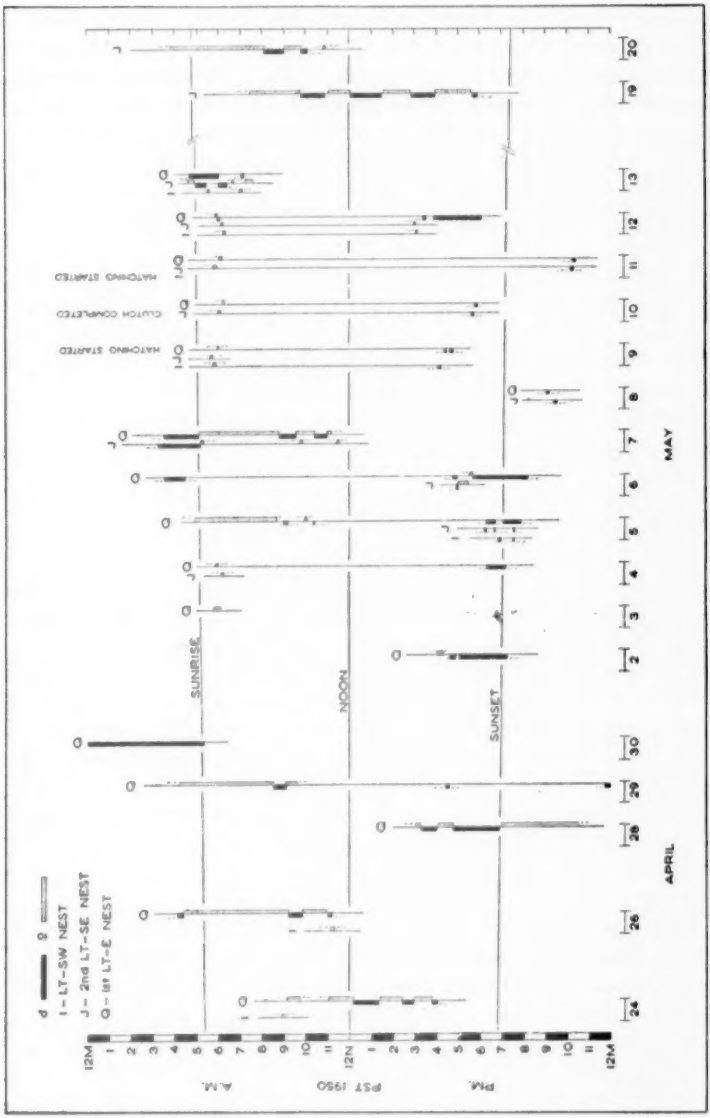


FIGURE 3. Length and pattern of incubation shifts.

and furthermore it seems probable that the male does the major share of it (figure 3). Out of 26 night observations, 23 indicated that the male was on the nest throughout the night. The female relieved the male shortly after daybreak and then took a four-hour shift. Through the rest of the day the shifts were of about one-hour duration until nearly sundown when the male generally took over for the night. Observations on three nests in different stages of incubation at Lake Temescal showed that only males were incubating at night.

At dawn the females relieved the males between 4:23 and 5:02 a.m. and remained on the nest until about 8:25 to 9:38 a.m., the shortest of three shifts being three hours and 45 minutes, and the longest, four hours and 50 minutes. The length of shifts through the daylight hours varied considerably. The shortest of 21 daylight shifts was 28 minutes while the longest was one hour and 39 minutes.

During four days of observations on the Lake Temescal E pair, the male averaged 47 minutes for seven periods, while the female averaged 56 minutes for five periods. During two days of observations on the Lake Temescal SE pair the male averaged 67 minutes in four periods while the female averaged 71 minutes in four periods. Three short periods of observation in 1950 on the Jewel Lake N pair, incubating its second clutch (fourth 1950 laying), indicated that their shifts varied somewhat from the Lake Temescal pattern, with no changes being observed during observation periods varying from one hour and 42 minutes to three hours and 22 minutes. The Lake Temescal SE pair, on its third clutch during this same period, maintained the same average schedule as on their earlier clutch (67 to 71 minutes).

As noted earlier, observations on the Lake Temescal SE pair in July, 1950, indicate that the female incubates during the nights in which the first three or four eggs are deposited, but with the appearance of either the fourth or fifth egg, the male assumes the role of night incubator which he apparently continues to play until the eggs are hatched.

Dusk shifts by males of up to two hours and ten minutes, followed by the female relieving them for the night, were recorded twice. On all five occasions that nests were checked shortly after sunset and again shortly before daylight the following morning, the same bird was found occupying the nest. If late evening changes were made, they occurred about sunset, otherwise, when the male went on the nest between 4:30 and 5:30 p.m., he remained on the nest until relieved at dawn by his mate. On only one night was the male's assumption of incubation and dawn relief observed; this period totalled 11 hours and 24 minutes.

On two nights that a female coot incubated, it was noted that she also incubated the greater part of her usual early morning shift. On the one occasion that the complete night period for the female was determined, it lasted for 13 hours and 27 minutes.

Incubation behavior.—In 1950 at Lake Temescal 17 nest changes between the E pair and 11 changes between the SE pair were observed. As a rule the males showed an impatience to commence incubation and then a strong desire to leave the nest when their turn was finished. Females were generally less hurried in their actions, remaining away from the nest until called or chased to it and then later not leaving the nest until the male was close by. Whenever the male was off the nest because of disturbance the female would go to the nest and commence incubation even though it was not her turn.

When not disturbed, coots always leave and enter the nest by way of the ramp. The departing bird makes no attempt to cover the eggs, though occasionally a bird forced to depart hastily may accidently scatter nest material over the eggs. The bird coming on the nest invariably spends about one minute preening and drying its breast feathers, standing on the top of the ramp while doing so. At this time the eggs apparently are turned and any needed nest repairs are made. An incubating bird was never seen working with the nest materials unless its mate brought some to the nest, and then the material was hastily placed on the nest rim. I have never observed egg turning by an incubating coot. Some birds slowly rotated on the nest while others always faced in one direction while incubating.

Following relief, each bird covered its territory, seeking out any intruding birds that might have entered while it was incubating. The female usually remained some distance from the nest, feeding and preening. The male, on the other hand, after an inspection of the area, returned to feed and preen in the vicinity of the nest until it was time for him to take his turn at incubation (figure 4).

The *bracing* display that frequently followed a change has been discussed in detail elsewhere (Gullion, 1952*b:* 89). How much of this display exhibited by the Lake Temescal SE pair was normal for the change is unknown, since the SE male was being subjected to the seductive gestures and calls of the interloping M female at this time.

The extent of nest defense against predators by the American Coot is difficult to determine. In the case of repeated nest disturbance on my part the degree of defense seemed to be strongly conditioned by the frequency with which the nest was visited. Nests visited daily were more vigorously defended than those visited less frequently.

Of course, the stage of nesting was important. Although some

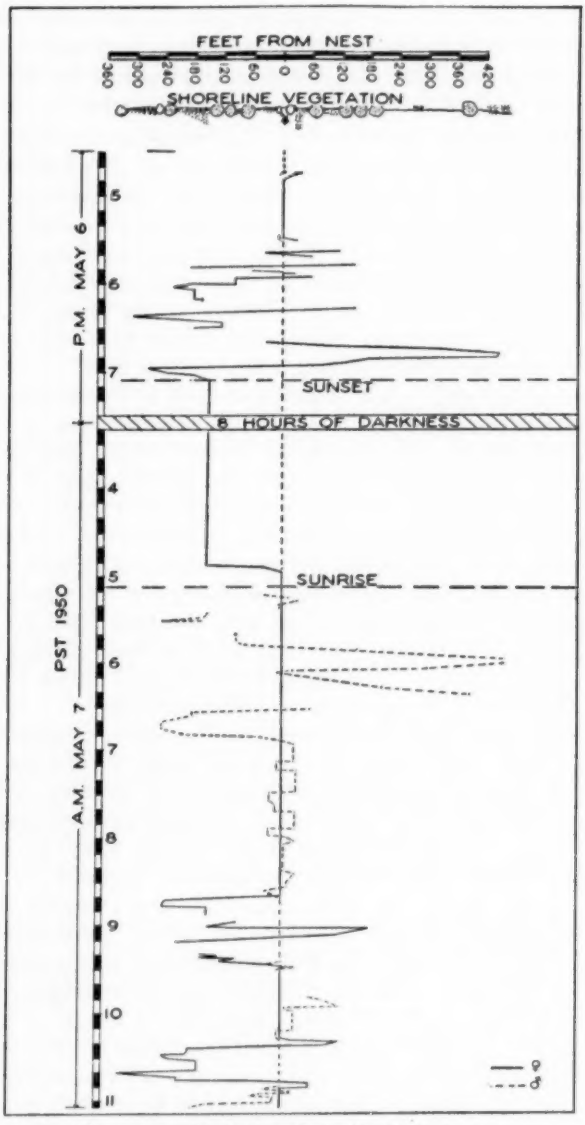


FIGURE 4. Wandering of non-incubating coots.

concern was generally shown when display platforms were disturbed, this generally amounted to no more than a few *poonks* or *puhlks* by the respective birds from some distance away. As the egg nest was built and eggs were laid, the birds came closer and occasionally *swanned* or if very frequently disturbed, they might *churn*. With the advance of incubation, defense became more vigorous, both birds *swanning* almost continually during the period of disturbance, with frequent and prolonged *churning*. When eggs began hatching, nest defense reached a peak, with defending birds actually attacking me. It was during this time that three nesting adults at Lake Temescal were taken by hand and subsequently tagged and banded. In fact, the SE female once climbed on the nest when I was present, and I had to remove her in order to continue my examination of the nest.

On one occasion, a dog waded into the vegetation near the Lake Temescal SE nest and the male quickly and quietly slipped off the nest to hide in the cat-tails. Since neither he nor his mate indicated any desire to defend the nest, it seems probable that little more than *swanning* constitutes nest defense against the larger predators.

Incubation period.—Of the nine successful nests I have studied, four have provided definite data on the period of incubation. The date of laying of each egg was known in three nests and the hatching dates of the fourth were such as to indicate a minimum period corresponding to that determined in the other three nests (figure 5). The five other nests were not located until after the clutch was complete and could not be correlated with other data.

Out of 11 eggs in three nests, marked the day they were laid, none was pipped before the end of the twenty-first day and none hatched before the end of the twenty-second day. Of these 11, five hatched during the twenty-third day, four on the twenty-fourth day, one on the twenty-fifth day, and the last hatched 26 days after deposition but perhaps after only 25 days of incubation (figure 5C and D). Of the eggs in the fourth nest, the last hatched during the twenty-third day after the nest was located, and since all but the first egg hatched at one day intervals previously, it is evident that all but the first egg hatched during at least the twenty-third day after deposition (figure 5A).

Sufficient data were obtained on four eggs to determine that the minimum period of incubation varied from 548 to 558 hours. Since these eggs were among the last deposited in their clutches, it is assumed they were deposited about 4 a.m. and their hatching times ranged from about midnight to after 10 a.m. on the twenty-third day, or between the twentieth hour of the twenty-second day and the sixth hour of the twenty-third day of incubation.

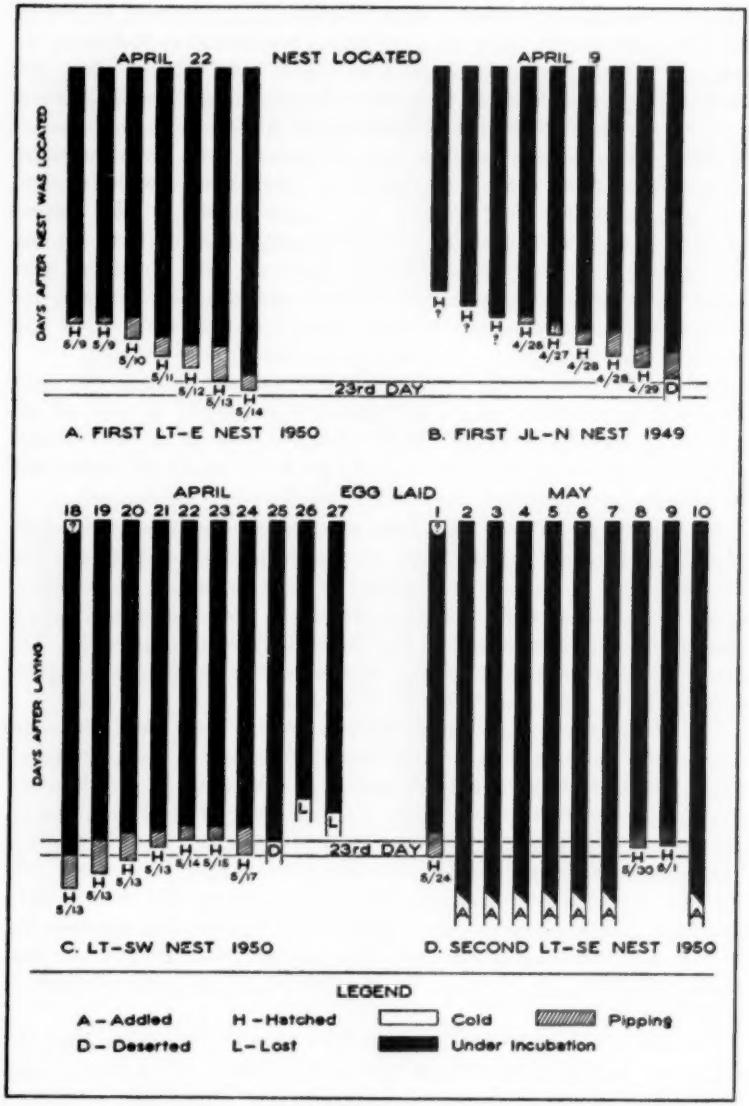


FIGURE 5. Length of incubation and hatching sequence.

Examining the literature, I have not found any published reference to an incubation period of over 22 days in this species. Some workers apparently calculated the incubation period as that period from the time the last egg was laid until the time the first egg hatched (which might have been as short as 11 days in the nests I studied). This may explain the 14 day incubation period published by Burns (1915: 282) and repeated by Bergtold (1917: 89). Bent (1926: 361) is most nearly correct when he states: "The period of incubation is 21 or 22 days." He does not indicate the source of his data. Subsequent authors have almost universally accepted Bent's statement, most of them giving the 21 day incubation period.

The suggestion is made by both Burns (1915: 281) and Bergtold (1917: 41–42) that climate might affect the length of incubation. Considering this possibility it might be worth noting that while the study areas in the San Francisco Bay area have a July average temperature of about 62° F (U.S.D.A., 1941: 783) the area studied by Sooter in Iowa (1941) has an average July temperature of about 75° F (U.S.D.A., 1941: 862). This temperature difference may account for the apparent difference in incubation periods between these two areas.

HATCHING

Sequence of hatching.—Since the eggs are generally under continuous incubation from the time they are laid until they hatch, the hatching is usually in the same one-a-day sequence as the laying.

As pointed out earlier, incubation in early nests is often delayed, with a consequent bunching-up of the hatching of the first eggs, but once hatching commences it proceeds at a fairly uniform rate (figure 5A, B, C).

Sooter (1941: 42) states, "hatching began 21 days after the first egg was laid, except in the earliest nests. The first nests required one or two days longer to start hatching." In the early nests I watched, hatching was delayed one to three days. In one nest four eggs hatched on one day, hatching during their twenty-third, twenty-fourth, twenty-fifth, and possibly twenty-sixth days respectively (figure 5C).

The commencement of pipping was hard to determine, but data on 33 eggs indicated that pipping begins from 12 to 76 hours before the chick frees itself from the egg-shell and is hatched. The average time seems to be about 36 hours. The duration of pipping does not seem to be correlated with individual pairs or with an egg's position

in the sequence of laying of the clutch. In other words, the length of time it took a full-term embryo to free itself from its egg-shell and egg-membranes seemed to be dependent upon the strength or determination of each chick and not upon possible hereditary influences of its parents or its position in the sequence of egg deposition.

Hatching failures.—Egg desertion, particularly of the last eggs in a clutch, appears to be frequent among coots. A stimulus to brood seems to operate after a certain number of chicks have hatched, and in brooding, the desire to incubate is overcome, thus limiting the number of eggs hatched from any one nest. Regardless of the size of the clutch, no more than eight eggs were hatched in any of the nests I had under observation. In one nest two eggs were dumped into the water and the nest converted for brooding purposes after the seventh egg hatched (figure 5C). The eighth egg was later recovered and found to contain a full-term embryo that should have been pipping the egg within hours of the time it was jettisoned. In another nest the ninth egg was deserted after it was pipped and although the young hatched, it soon died from neglect (figure 5B).

A survey of the literature reveals that broods of more than eight young coots are uncommon and normally there are fewer, this in spite of frequent clutches of more than eight eggs. Hendrickson (1936: 216) reports five as the largest brood he studied in Iowa and later Friley *et al.* (1938: 84) repeated the observation in the same area, but they noted that the "hatching of larger broods was common." Sooter (1941: 45–46) presents tabular data that may support my observations, though he does not draw the same conclusions. In 1937, he recorded an average hatch of 8.22 eggs per nest out of an average clutch of 8.45 eggs. Miller (1946: 12) indicates that few broods of more than eight birds occur in the Black Gallinule (*Gallinula chloropus*). While these data are not conclusive, they do point to a problem that should be investigated further.

It is my belief that the calls of young coots stimulate the parents to brood rather than incubate. So long as there are few young moving or calling from under the incubating adult, the stimulus to incubate remains predominant and one bird sticks close to the eggs. However, the activity of seven or eight young coots causes sufficient stimulus of a different nature to initiate brooding and feeding behavior and to terminate incubation. The activity of a single young has little effect upon the desire to incubate and is unable to excite a strong feeding stimulus in the parents. In the case of the consistent failures of the three nests of the Lake Temescal SE pair in 1950, the feeble activities of the single chick were not sufficient to excite con-

sistent care by the adults, and it perished before the hatching of another egg could initiate additional brooding stimulus. The nearly full clutch of eggs remaining retained control of the parents' instincts to incubate. On the other hand, in more successful nests, the stimulus provided by the activity of an increasing number of chicks not only stimulated the parents to care for the first hatched before it perished but also to provide adequate care for the chicks subsequently hatched. As the motionless eggs turn to active, noisy chicks, the incubation instinct becomes overwhelmed by the desire to brood and feed, and the adult birds cease incubation of the remaining eggs and turn their full attention to caring for the young.

If this behavior is as general as it appears to be, it means that a coot brood of about eight is the maximum usually hatched even though the nest may contain more than eight eggs. This would definitely limit the productivity of the species and illustrates a disadvantage of staggered hatching. In waterfowl and gallinaceous birds having large clutches, a simultaneous hatch insures full-term incubation for most or all of the eggs and parental care for the young once they have hatched.

A second factor preventing the hatching of eggs is, of course, sterility. The SE pair at Lake Temescal laid more sterile eggs than fertile ones. In 1950, they laid their first clutch in late March and did not commence incubating until the eighth and last egg was laid on March 29. Only the last egg of this clutch hatched, after 23 days of incubation, on April 21. On this date six eggs remained in the nest, and two of these were found to be rotten.

A second clutch was commenced in this same nest on May 1, while eggs of the first clutch still remained. On May 5 there were five new eggs and one old egg, all under incubation. A fresh egg replaced the old egg on May 6. The hatch of the second clutch was extremely irregular, the first, eighth, and ninth eggs hatching from a clutch of ten (figure 5D). The stimulus provided by the last two young was sufficient to start parental care, though the first chick was allowed to die. Despite two constantly begging young, incubation of the six remaining addled eggs continued for about eight days after the last egg hatched.

Twenty-six days after the hatching of the second clutch the SE pair started its third clutch. This clutch was under incubation from the first egg, but only the sixth egg of the clutch of seven hatched (an eighth egg was lost from the nest earlier).

It seems possible that the partial sterility in this pair resulted from senility in one or both birds. This pair fledged at least three young

in 1949, but only one young was fledged out of three nesting attempts in 1950. Romanoff and Romanoff (1949: 12) indicate that egg productivity in domestic chickens decreases with advancing age, and "the period during which their eggs are fertile is even shorter." They further indicate that reproductive capacity in the male fowl declines at a faster rate than in females. This perhaps may not be true of the American Coot, but it does present a possible explanation for the erratic hatch of the eggs of the SE pair at Lake Temescal in 1950.

The ages of the SE birds are not known, but the male did possess yellow-orange legs like those found on an eleven-year-old banded female at Lake Merritt. It seems possible that the male was the senile individual in this pair, since the reproductive capabilities of the female seemed to be unimpaired, as she deposited three clutches totalling 26 eggs in a period of 105 days.

The eggs that became addled in other nests apparently had been laid consecutively, since the hatch, once begun, normally proceeded uninterrupted. Unfortunately, none of these nests was found early enough in its history to determine at which end of deposition the addled eggs were laid. Although the hatching pattern in one nest indicated that the fourth and sixth eggs of a clutch of seven became addled, it is possible that it was the earliest eggs that became addled in other nests. If so, these data suggest a possibility that delayed incubation allowed the earliest eggs to be killed by chilling, as discussed earlier.

Cessation of Incubation

In four nests incubation ceased quite promptly when eggs failed to hatch on schedule. In 1949 and 1950 at Jewel Lake, nests were deserted the day the last fertile egg hatched, leaving two or three addled eggs behind. Even the three LT-SE nests, carrying nearly full clutches of addled eggs through the normal incubation period, were incubated for only seven or eight days after the last egg hatched or was due to hatch.

Leopold (1933: 367) indicates that some gallinaceous birds incubate addled clutches for many days after the hatch should have occurred (up to 56 days in Bobwhites, *Colinus virginianus*). I believe this is also true of many ducks.

Large Clutches

The carry-over of eggs, as it occurred in the first LT-SE nest, might explain the clutches of over a dozen eggs that frequently are reported for this species. The idea of two females depositing eggs in one nest

is hardly compatible with the extreme territorialism exhibited by the American Coot (Gullion, 1953*b*). Also, since a bird is normally on the nest continually from the time the first or second egg is laid, a strange female would have little chance to slip in and deposit one egg, much less six or seven. Hence, clutches of more than 12 to 14 eggs probably represent telescoped cycles of egg deposition by one female. Sooter (1941: 41) indicates this in his study of coots in Iowa, and Alley and Boyd (1947: 199) record instances of this sort in the Black Coot (*Fulica atra*). However, Alley and Boyd also record a certain amount of promiscuous laying.

CARE AND DEVELOPMENT OF THE YOUNG COOT

The first five days.—The newly hatched American Coot is a grotesque little creature. Its body is covered with dense black down, tipped with brightly colored plumes. On the dorsal surface and wings, these plumes are long and orange, but on the ventral surface they are short and yellow. A ruff of wire-like filoplumes encircles the neck. The bald pate lacks any sort of covering, and there is light blue skin over the eyes. A number of orange, waxy, club-shaped structures tip the down at the base of the bill and around the eyes. The tip of the bill is black; the egg tooth is white, grading into the orange that extends back to the front edge of the nares. The bill and frontal shield from the nares back are fleshy and a deep blood red (plate 30C). The legs and feet are a transparent greenish-gray, and a claw one millimeter long tips the pollex. The young coot's eyes are open when it emerges from the shell, and it holds its head steadily erect at the age of 15 minutes. The newly hatched coot weighs between 19 and 22 grams wet, and the yolk stalk is sealed across about 10 minutes after hatching. The feet are perhaps its most prominent feature. They are about one-third of the adult size, and the swimming lobes are well developed (table 2). The young coot gives a characteristic *whewr* note from the time it first pips the egg.

By the time the young coot is six hours old it has dried out and lost a gram or two of weight. It is quite buoyant and can climb in and out of the nest and swim to cover once it is on the water (plate 30D). However, in undisturbed nests, it is probable that young coots do not leave the shelter of the incubating parent for many hours after hatching, perhaps even for a day or two.

When nests are disturbed, every young goes over the side, except those that are less than 15 to 20 minutes old. Those young that go out of the nest before they are dry and fluffy generally drown. They are not yet buoyant, and they lack sufficient strength to keep on the surface of the water for more than two or three minutes.

TABLE 2

SIZE COMPARISONS BETWEEN DIFFERENT AGE CLASSES OF AMERICAN COOTS (ALL DATA FROM LIVING BIRDS OF UNKNOWN SEX)

Age	*Bird*	*Weight (grams)*	*Tip of bill to top of frontal shield (millimeters)*	*Middle toe length (millimeters)*	*Tarsal length (millimeters)*	*Hallux length (millimeters)*	*Pollex claw length (millimeters)*
At hatching	—	—	14.8	25	20	8.5	1
At hatching	—	22.4 (wet)	—	—	—	—	—
At hatching	R-3	17.4 (dry)	—	—	—	—	—
At hatching	L-3	19.6 (wet)	—	—	—	—	—
6 hours+	—	22.1	—	—	—	—	—
3 days	R-2	25.9	—	—	—	—	—
9 days	R-3	51.2	18	28[1]	21	11	1.5
10 days	R-2	34.1	16	25[1]	18	10	—
19 days	R-2	55.9	20.5	34	21	11	2
28 days	607	166.9	28	54	36	18	2
36 days	608	223.1	28	60	41	19	—
64 days	040	392	35	64	44	18	3
71 days	035	492[1]	39	65	49	19	—
73 days	034	447[1]	40	67	48	21	4
78 days	035	498	—	—	—	—	3
82 days	034	404	40	68	50	—	—
Adult female*	033	432	45	60	42	20	—
Adult male*	037	656	48	73	54	24	—

[1] Apparent discrepancies are probably due to sexual differences (see Gullion, 1952a).
* Parent pair of birds R-2, R-3, L-3, 034, 607 and 608—Jewel Lake N broods, 1949.

Since the first eggs in a coot clutch are often hatched a week before the last, one parent takes over the major share of incubation while the other seeks food for the young already hatched. Usually the male incubates during this period, also brooding those young not feeding with the female. Although the female occasionally relieves the male on the nest, she probably does not incubate for more than one or two hours a day.

If the nest is disturbed during the hatching period, the female takes the older members of the brood away from the nest to safety while the male stays to defend the nest and the young and eggs remaining in it.

The female frequently comes to the nest with food for the young, which is exclusively animal matter for the first few days after hatching. At Jewel Lake, in 1950, the female was observed collecting large numbers of freshly emerged dragon-fly (Anisoptera) and damsel-fly (Zygoptera) imagoes for her young. The two- and three-day-old young got off the nest and swam several feet to await the approach of the food-laden hen. After being fed several times they returned to the nest and the protection of the incubating male.

A brood nest is contructed as soon as the eggs start hatching, and

after three or four days the female broods the older, more active chicks at night on this nest while the male incubates the remaining eggs and the newly hatched young on the egg nest.

When a sufficient number of young has hatched (about eight), both parents turn their attention to care of the young and desert the remaining eggs or dump them out of the nest, as discussed above. When about five days old, the young begin to spend the major share of the day-time following their parents on foraging excursions in the emergent vegetation. At this stage the alarm notes of their parents are enough to send the chicks scurrying into hiding.

Six to fifteen days.—During this interval there is a general loss of ventral body plumes, and the dorsal plumes bleach (see table 3). Growth is rapid, and young coots quickly develop proficiency in swimming, diving, and fighting.

Frequently some of the young are left in dense cover while both parents forage with other young. For example, in one 1949 brood at Jewel Lake, on ten occasions on seven different days, both parents were seen feeding with two to five young from a brood of six. In fact, this brood was 21 days old before all six young were seen at one time. During the greater part of the first three weeks, only one to four young were seen at any one time. This characteristic of coot behavior precludes reliable counts of broods.

By the time they are eight days old, young coots are consuming considerable quantities of vegetable matter. Among the earliest vegetable food observed to be taken were the white, starchy bases of cat-tail leaves and fine bits of sago-pondweed.

The time spent brooding decreases considerably by the end of the first week, and by the end of the second week the young are seldom, if ever, brooded during daylight hours. At night both parents probably share in brooding, since two brood nests are in constant use through this period.

Sixteen to thirty days.—During this period the growing coot undergoes a striking plumage change. At an age of about 25 days the breast becomes whitish, contrasting sharply with the otherwise very dark plumage of the young bird. Juvenile feathers are generally replacing the natal down everywhere except on the wings and tail.

There is quite a bit of variation in the rates of growth of different young coots. Although this variation was usually least within broods, in at least one instance one young lagged 11 days behind its broodmates in getting its distinctive white breast.

The duration of the brooding period is not known definitely, but

TABLE 3

GROWTH AND DEVELOPMENT OF THE YOUNG COOT

Age in days	*Weight in grams*	*Plumage and soft parts*	*Voice*	*Activity*
2		Same as newly hatched young (see plate 30D and text).	*whew*	Swims well and assumes begging display.
4	25–30	All colored body plumes gone from ventral surface and many lost from back; club feathers and filoplumes becoming prominent on head.		
6		The few remaining body plumes bleached white.		Dives and assumes the fighting posture of the adults.
10	35–55	Body covered with dense black down tipped with white bleached plumes. Wing plumes and head filoplumes still orange, and club feathers prominent. Bald pate present and looks sunburned.	A *peep* when in trouble.	Can swim under water readily and fights proficiently.
15		All body plumes lost but plumes remain concealed on wings. Head filoplumes faded, giving hoary appearance to head; few club-feathers remain. Bill a bright red-orange.		Dives for vegetable food and begins to preen and to move independently of parents.
20	60–80	Dorsal body surface covered with dense black down; and ventral surface with dense brown down. Some colored filoplumes remain around edge of pate, but all the rest are bleached white; a few club-feathers remain. Skin over eyes still blue, and pate is bald and "sunburned," with two rows of black feathers becoming apparent. Bill still has black tip; white egg tooth grades rapidly into red-orange portion distal to nares. Base of bill and frontal shield a bluish-red; shield shows definite development. Iris dark gray-brown; legs dark gray-green.		Chases insects and feeds by tipping and diving.

TABLE 3—(*continued*)

Age in days	*Weight in grams*	*Plumage and soft parts*	*Voice*	*Activity*
25		Two white spots appear laterally on breast at water-line and spread so that only narrow stripe of black separates them the next day. On 27th day white has extended to throat and head. Head filoplumes all bleached; bill has turned pale orange.		
28	160	Dorsal body surface covered with very long black down. Natal down and a few faded plumes remain on wings. Breast and throat covered with dark gray, light tipped feathers; side of neck and cheeks covered with very light gray feathers with black tips. Narrow black stripe splits light breast and belly plumage. Flanks have medium gray feathers. Pate covered with light gray, black tipped feathers, forming *halo;* rectrices and remiges show no development. Oil-gland developed and tufted. Egg tooth has disappeared, and bill is encircled by broad black band just distal to nares. Tip of bill an orange-gray-green with base grading from light flesh color around nares to deep blood-red on shield. Iris very dark, opaque, gray-green.		Dives and tips for food; one dive of 15 seconds noted. Young seldom fed by parents.
36	200–225	Dorsal body surface covered with dark gray; ventral surface with light gray teleoptiles. Natal down still covers wings; few faded filoplumes remain on head. Under-tail coverts formed but still concealed. Bill has greenish tip, followed by black band, and from nares back, grades from yellow-green thru flesh color to blood-red on shield where blood capillaries are visible. Whole of bill streaked with narrow, dark pencil-like streaks. Iris and legs gray-green.	A dimorphism is apparent—calls *pzeep* and *pweep* in addition to the natal *whewr*.	Feeds in brood flocks.
40		"Halo" fully developed, forming dark skull cap. Back of neck becoming medium gray with some dark feathers appearing among lighter feathers on side of neck resulting in a speckled effect. Breast remains light gray.		

TABLE 3—(*continued*)

Age in days	*Weight in grams*	*Plumage and soft parts*	*Voice*	*Activity*
42–44		Breast darker, and tail developed with under tail coverts becoming visible. Bill becoming very dark.		Feeds independently with brood-mates in loose flocks but still heeds calls and warnings of the parents.
45–55		Body generally medium gray. Bill, after being dark, begins to turn light again.		Feeds without parents.
60		Two dark gray spots become apparent laterally on breast at water-line. Rectrices developing rapidly, but remiges not yet apparent.	A poorly developed adult *poonk* and the natal *whewr*.	
70	Average adult (♂♂, 498; ♀♀, 495)	Top of head dark gray, back gray-brown, rump reddish-brown, throat medium gray. Rectrices ¼ sheathed; remiges still ½ sheathed. Bill light, mottled ivory distal to nares, base smooth medium gray. Frontal shield flesh colored; iris grayish on perimeter becoming reddish-brown towards pupil; legs gray-green.		
75		Remiges fully unsheathed, bill uniform grayish-ivory, iris reddish, frontal shield reddish.		Beginning to fly.
80		Immature resembles adults in all characters except for grayish bills and gray-green feet and legs.		Leaves home territory.
120		Bill begins to look adult; from this time on immatures can be separated from adults only on basis of leg color (see text).		

one hen on Lake Temescal was still occupying a brood nest with her three young 46 days after the last had hatched. It is believed, however, that she was sharing a night roosting place with them rather than actually brooding them. On several subsequent nights these young occupied the nest by themselves while their parents roosted on floating debris nearby.

Hollister (1919), watching captive American Coots at the National Zoological Park, noted that the young were brooded by the female at night for about 20 days following hatching. Ward (1953: 323) reports a general abandonment of family duties by males during the rearing period. These coots were summer residents in Manitoba and presumably without the strong ties to a local area that permanent-resident coots exhibit.

By 16 to 20 days the young coots feed themselves to a large extent and by 30 days are independent, though still often feeding in company with their parents. By this time brood counts become more reliable, since the immatures of each brood tend to become a closely knit group.

Thirty-one to fifty-five days.—The young coots enter this period with the whitish breast and most of the body down replaced by definitive feathers. The light breast is soon replaced by a medium-gray breast, the white undertail coverts appear, and the top of the head develops a dark haloed appearance.

At the end of this period, the bird has its full juvenile plumage and has assumed the body proportions of the adult. A coot of this age responds to aggressive displays of outside adults by evasive action and frequently chases immature ducks out of its home territory.

In one instance a juvenile was 60 days old before it showed the white under-tail coverts. The variation in growth between broods was most noticeable. One Lake Temescal brood developed so slowly that its parents failed to renest in 1950, while all other pairs in the area were bringing off second broods.

When 40 to 45 days old the juvenile coots are foraging almost entirely without their parents but usually in company with one or more brood-mates.

Fifty-six to eighty days.—At about 60 days the first dark adult plumage appears as two black spots laterally and just above the waterline on the breast. This dark plumage rapidly spreads over the entire body. The remiges and rectrices develop almost entirely during this period and the immature coot flies at about 75 days of age. The first indication of an adult voice becomes apparent.

Even as late as 70 days after hatching, immatures occasionally are seen to assume the begging display and to receive food from their

parents as a result. Normally at this age, begging results in being pecked rather than receiving food, so the immatures are hesitant about approaching the adults closely.

The immatures closely resemble adults by the time they are 80 days old, and their parents have generally driven them from their home territory, perhaps regarding them as territorial invaders. They differ from the adults in possessing a darker, grayish bill and gray-green feet and legs. They are as heavy as the average adult.

Development after eighty days.—At about four months of age the bill of the immature resembles that of the adult sufficiently that age identification cannot always be certain, though some immatures retain a mottled bill in excess of five months. Once the bill is like that of the adult, only the gray- or blue-green feet and legs serve to separate the birds of the year from adults. The frontal shield on immature coots is characteristically flat, but this cannot be used as an age criterion since adults in non-territorial, non-breeding condition will also have flat shields (Gullion, 1951*b*). Leg color remains diagnostic until the following spring when the legs become greenish-yellow.

By the second year, the legs have become clear bright yellow, and each season thereafter the coot's legs apparently become progressively darker yellow, tending towards orange. This darkening was accomplished by the shedding of leg scutes, one at a time, during the spring season by birds held captive during this study (Gullion, 1953*a*).

An American Coot that is ten or eleven years old will have reddish-orange legs, but otherwise the plumage is much the same as in a five-months-old immature coot.

The age at which American Coots commence breeding is not known definitely. However, it is known that at least some females may breed during their first year. As noted above, one year-old female on Jewel Lake, mated to her father, proved very prolific in 1950, having laid five clutches of eggs (37 in all) during the season. Territorial activity probably has more control over the breeding age of coots than has physiological maturity.

RENESTING

The American Coot, like many other birds, renests if its early nests are destroyed and, unlike most game birds, it also may raise a second brood following the successful rearing of one brood. This is at least true in the San Francisco Bay area, although Sooter (in correspondence) is quite certain that this was not the case in his study area in Iowa.

During this study four nests were lost: two deserted apparently due to my activities, one lost to a predator (raccoon suspected), and a fourth to uncertain causes. The two deserted nests were the second and third clutches of the JL-S pair in 1949 while the last two were the first and third nests of the JL-N pair in 1950.

The third clutch of the 1949 S pair was started not later than seven days following desertion of their second nest, and the second clutch of the 1950 N pair at Jewel Lake followed no later than four days after the destruction of their first nest. Following the successful rearing of a brood from its second clutch, the JL-N pair laid a third clutch, which mysteriously disappeared while still being deposited, and the fourth clutch was commenced not over four days following its loss.

In both of the 1950 nest losses the clutch was either still being deposited or had just been completed, so the female probably was still in the physiological state necessary for continued egg production. This fact is not known for the two 1949 nests. Sooter (1941: 47) by removing eggs from nests during the deposition period was able to get females to lay from 14 to 18 eggs. The JL-N pair in 1950 almost equalled this by laying 17 eggs in 23 days.

In all three instances the renesting required the selection of a new nest site and building a new nest. In at least the last case a new display platform also was built.

Both pairs at Jewel Lake in 1949, the one pair at Jewel Lake in 1950, and two of the three pairs at Lake Temescal in 1950 laid clutches following the successful rearing of an earlier brood. In 1949, at Jewel Lake, the S pair laid its second clutch not over 40 days after hatching their first brood while the second clutch of the N pair appeared 38 days after hatching their first brood. In 1950, the third clutch of the JL-N pair appeared not over 30 days after the successful hatch of its second clutch. At Lake Temescal in 1950, the SE pair began laying its third clutch 26 days after a partially successful hatch of its second clutch while the E pair commenced laying its second clutch 56 days after the hatch of its first clutch. In each case a different, though not necessarily new, nest was used for clutches following successful rearings.

The stimulus that determines when a new clutch is to be laid is unknown. The variation in intervals cannot be related definitely to brood size or age, to the size of clutches laid previously that season, or to the success of earlier layings (see table 4).

The American Coot appears to show great variation in the length of time between the hatching of the first clutch and the laying of

TABLE 4

CLUTCH SIZE AND BREEDING SUCCESS

		Clutch Number															
		1			*2*			*3*			*4*			*5*		
Season and pair	*Interval between broods (days)*	*Eggs*	*Hatched*	*Reared*	*Eggs*	*Hatched*	*Reared*	*Eggs*	*Hatched*	*Reared*	*Eggs*	*Hatched*	*Reared*	*Eggs*	*Hatched*	*Reared*
1949																
JL-S	40	10	8	7	6	deserted		4	deserted							
JL-N	38	9	8	6	6	6	4									
1950																
JL-N	30	10	destroyed		7	5	5	7+?	destroyed?		8	4	0	5+?	3+?	3+?
LT-E	56	7	7	1	4	4	1									
LT-SE	26	8	1	0	10	3	1	8	1	0						
LT-SW	—	10	7	3												

the second. Sooter (1941: 41) records one nest that hatched two broods, with the eggs of the second clutch appearing within 48 hours following the successful hatch of the previous clutch. He believed the second clutch was the product of a different pair but gives no evidence to support his belief. In view of the strong territorial behavior displayed by breeding coots, this would be very unlikely in the area I have studied, and I doubt that the territorial behavior of Iowa coots differs that much from the birds in western California. He makes the statement (p. 41), "On several occasions eggs were laid in nests while they were hatching or shortly before the hatching period began."

HATCHING AND FLEDGING SUCCESS

During this study, a total of 119 eggs was laid in 16 nests by six pairs of coots (table 4). Of these, 57 eggs (48 per cent) hatched, 27 eggs (23 per cent) were addled, 17 eggs (14.5 per cent) were taken by predators, 10 eggs (8.5 per cent) were deserted, 4 eggs (3 per cent) were lost to unknown causes (knocked out or buried ?), and 4 full-term embryos (3 per cent) were left to die in the nest or jettisoned at about the time they were due to hatch. Thirty-one young fledged, representing 54 per cent of the eggs hatched or 26 per cent of the eggs laid.

In 1949, the season's productivity at Jewel Lake amounted to 8.5 young per pair, while in 1950 the single pair produced eight young. At Lake Temescal in 1949, the season's productivity was at least 3.3 young per pair while in 1950 it was 2.0 young per pair.

Sooter (1941: 71) in his Iowa study, estimated a fledging success of 1.9 young per pair. Kiel and Hawkins (1953: 320) found a 97 per cent successful hatch among 380 nests studied in southwestern Manitoba, with a 99 per cent hatch among "1,394 eggs in successful nests with complete clutch counts." The overall productivity in the Bay Area study in 1949 was 5.4 young per pair, in 1950 about 3.5 young per pair, with a total survival for the two years of about 5.1 young per pair. Survival per successful clutch amounted to about 3.4 immature coots.

PARENT-YOUNG RECOGNITION

As discussed above, and noted in table 3, the developing young coot goes through quite an array of abrupt plumage changes. Since there may be a week's difference between the age of the oldest and youngest bird in the brood, the oldest bird may have become almost

wholly white-fronted before the birds in the middle of the brood begin changing. Similarly, the youngest bird may still retain the solid black natal down while all its brood-mates are turning much lighter.

Since the parents seem to recognize their brood by the color pattern of the majority, the oldest birds become subject to occasional attacks when they start turning light. As more young progressively turn light, the parents accept the light-fronted birds as theirs, and the attacks are directed at the younger birds, still in their natal down. Sometimes these parental attacks are quite severe, and it is conceivable that young might occasionally be killed by their parents during this transition period.

The parent coots are obviously confused by this change in the appearance of their young, since they frequently will bill an odd-colored young, feed it, and then severely attack it, only to resume feeding it immediately afterwards.

Alley and Boyd (1950: 46), in a study of parent-young recognition in the Black Coot, have noted that "parent Coot will attack and drive away chicks conspicuously older or younger than their own." They did not note the same reaction to the plumage differences of birds at the extreme ends of large broods. No experiments were made in the Bay area concerning brood mixing, but Alley and Boyd noted that if strange young of the same age were placed in Black Coot broods less than 14 days old, they would be accepted by the parents.

During this period it would seem that only strict territorial defense and aggressiveness would prevent a great deal of mixing of young broods in areas where many pairs breed. Hence, one function of increased pugnacity following the hatching period might be the maintenance of brood integrity (see Gullion, 1953*b*: 179–180).

BREEDING BEHAVIOR OF OTHER RALLIDAE

Among members of the family Rallidae, only the Black Coot and Black Gallinule in Europe seem to have been investigated along the lines reported in this paper. Details of the nesting habits of most members of the rail family are apparently little known. However, a review of what is known will permit some interesting comparisons with behavior of the American Coot.

Pairing.—Monogamy in the Rallidae is probably quite general. It seems probable that monogamy would be necessary in those species in which both sexes incubate. The genera *Rallus*, *Rallina*, *Porzana*, and *Gallinula* in addition to *Fulica* show this shared incubation be-

havior, and monogamy is probably general in at least these genera (see table 5). The Corn-Crake (*Crex crex*) however is polygamous (Mason, 1947: 192), and correlated with this, only the female incubates. On the other hand, the Blue Reed-Hen (*Porphyrio poliocephalus*) is apparently also polygamous, the male incubating the eggs of two to six hens in one nest (Oliver, 1930: 348).

Stuart Baker (1929: 35) believes the Black Coot in India pairs for life, and Oliver (1930: 330) says the same is usually true of the Weka Woodhen (*Gallirallus australis*).

Nesting.—Nesting behavior in the Black Coot (Witherby *et al.*, 1947: 205), Red-knobbed Coot (*Fulica cristata*—Priest, 1934: 30), and the Red-gartered (*F. armillata*), White-winged (*F. leucoptera*) and Red-fronted coots (*F. rufifrons*—Gibson, 1920) seems closely to resemble that of the American Coot. The members of the several genera more or less closely related to *Fulica* usually build their nests of marsh vegetation, either floating on the water or on shore immediately adjacent to water. This includes the genera *Porphyrio*, *Porphyrula*, *Gallicrex*, and *Gallinula*.

Nest locations of other Rallidae are highly variable. The extinct Chatham Island Rail (*Cabalus modestus*) nested in holes in the ground (Oliver, 1930: 327), and this may also be true of the Island Hen (*Atlantisia rogersi*—Lowe, 1928: 102), but this is perhaps unique for the family. Most genera have nests located in marsh vegetation or in rank grass closely adjacent to water. However, some exceptions are the Australian *Eulabeornis*, which builds a nest of sticks on the roots of mangroves (Mathews and Iredale, 1921: 196) and the Palearctic *Crex*, which regularly nests in grain or hay fields or pastures, as does also the North American *Coturnicops*. The Oriental genera *Rallina* and *Amaurornis* generally nest in forested or bushy areas far removed from water and often above the ground. The White-breasted Water-Hen (*Amaurornis phoenicurus*), for example, often builds its nests "in thick bushes many feet above the ground" (Stuart Baker, 1929: 24). The highly adaptable Woodhens (*Gallirallus*) of the Australian region nest wherever food is abundant. The nest may be (according to Oliver, 1930) in the forest or scrub, under a leaning tree trunk, under a clump of rushes, in a flax bush, or under rocks. Smith (1952: 400) says of the recently rediscovered Takahe (*Notornis mantellii*), "The three- to four-month nesting season begins . . . when every pair prepares a number of nests, each consisting of a grass bowl with at least two entrances, set between thick snow grass tussocks . . . . The last to be made is apparently chosen for actual egg laying."

The rails as a group use whatever vegetation is most readily available—usually grasses and aquatic plants but occasionally sticks and other materials. Nests are usually lined, and a ramp by which the incubating bird enters and leaves the nest is constructed by rails of several species (table 5).

The Black Coot builds nests which it uses for brooding its young (Kirkman, 1912: 453), and the Red-knobbed Coot apparently builds platforms and other structures much like those of the American Coot (*cf.* Jackson, 1938: 308–309). The Black Gallinule builds both display platforms and brood nests (Howard, 1940). Walkinshaw (1937: 471) suggests that brood nests are built by the Virginia Rail (*Rallus limicola*), and it seems probable that the "three to four empty nests in the vicinity for every occupied one" (Bent, 1926: 350) of the Purple Gallinule (*Porphyrula martinica*) represent display platforms and brood nests. The extra nests of the Clapper Rail (*Rallus longirostris*) mentioned by Grinnell *et al.* (1918) may also represent brood nests. The Green-backed Reed-Hen (*Porphyrio madagascariensis*) of East Africa is known to build excess nests that are used at least for roosting (Jackson, 1938: 320).

Copulation.—Höhn (1949: 209) studying the Black Coot in England, reported a sequence of events and displays similar to that elaborated for the American Coot above. The brace, arch, and mounting proceed as in the American Coot, with the male not taking hold of the female's head but maintaining balance with his wings and feet. He recorded a high-pitched call but did not know which sex gave it and observed post-coital preening in only one instance. However, this sequence differed in that, "The plumage is held as in the common aggressive pose," apparently the swimming arch, preceding movement to the platform.

Nylund (1945: 121) speaking of the Black Coot in Finland, says, "The first mating takes place about one day before the laying of the first egg, the last at the time of the laying of the last egg."

Egg deposition and clutch size.—Apparently many Rallidae deposit one egg a day until the clutch is complete (see table 5).

A survey of the literature reveals that the clutches of six to ten eggs of Bay area coots are about normal for the species. However, as pointed out by Lack (1948: 27) the tropical Rallidae tend to have smaller clutches than the more temperate species. The Rallidae of England, for example the Black Gallinule, have clutches of from five to eleven eggs (Witherby *et al.*, 1947: 200). The same species in the Phillipines, however, averages four eggs (McGregor, 1909: 78), and the clutches of the tropical Rallidae range from the minimum of

TABLE 5

BREEDING BEHAVIOR OF THE RALLIDAE[1]

Species	*Pairing*	*Nest ramp*	*Brood nests*	*Eggs deposited*	*Clutch size*	*Incubation*			*Number broods*	*Authority*
						Commences	*Sex*	*Period*		
Clapper Rail (*Rallus longirostris*)			used		8–9					Grinnell *et al.*, 1918
							both			Bent, 1926
									2	Forbush and May, 1939
				daily		last egg	both	22–23?		Kozicky and Schmidt, 1949
King Rail					6–14		both?			Trautman, 1940
(*Rallus elegans*)	monog.			daily	8–14	late eggs	both	21–24		Meanley, 1953
Virginia Rail					5–12					Grinnell *et al.*, 1918
(*Rallus limicola*)					7–12	1st eggs				Bent, 1926
			used	daily			both			Walkinshaw, 1940
								19–20		Mousley, 1940
Water Rail (*Rallus aquaticus*)				daily	6–11	last egg	both	19–20		Witherby *et al.*, 1947
Slate-breasted Rail (*Rallus pectoralis*)		used			4–6					Mathews and Iredale, 1921
Argentine Rail					4–5		both?			Gibson, 1920
(*Ortygonax rytirhynchos*)					6–8					Schmidt, 1948
Spotted Rail (*Pardirallus maculatus*)		used			7					Sclater and Hudson, 1889
Red-legged Banded Rail (*Rallina fasciata*)					5–6		both			Riley, 1938
Ypacha Rail								21		Bergtold, 1917
(*Aramides ypecaha*)					4–7					Schmidt, 1948
Weka Woodhen (*Gallirallus australis*)	monog.				4			20		Oliver, 1930
Black Woodhen (*Gallirallus troglodytes*)	monog.				2–3		both	27	2	Oliver, 1930

TABLE 5 (cont.)

Species	*Pairing*	*Nest ramp*	*Brood nests*	*Eggs deposited*	*Clutch size*	*Incubation*			*Number broods*	*Authority*
						Commences	*Sex*	*Period*		
African Crake (*Crecopsis egregia*)					5		both?			Jackson, 1938
Corn-Crake (*Crex crex*)									2	Morris, 1892
							♀	17?		Kirkman, 1912
								19		Niethammer, 1942
	polyg.									Mason, 1947
				daily	8–12	last egg	♀	?	1–2	Witherby *et al.*, 1947
Little Crake (*Porzana parva*)								21–24		Evans, 1891
					7–8	1st egg	both		2	Witherby *et al.*, 1947
Marsh Crake (*Porzana pusilla*)					4–8					Mathews and Iredale, 1921
				daily	6–8		both	20–21		Witherby *et al.*, 1947
Spotted Crake (*Porzana porzana*)					8–12	1st egg	both	18–21	2	Witherby *et al.*, 1947
Sora Rail (*Porzana carolina*)					10–12	1st eggs				Grinnell *et al.*, 1918
					10–12		both			Bent, 1926
		used		daily			both	16–19	1	Walkinshaw, 1940
Spotless Crake (*Porzana tabuensis*)					4–6					Lucas and LeSouëf, 1911
					3–4					Mathews and Iredale, 1921
	monog.		used		3		♀			Oliver, 1930
Water-Cock (*Gallicrex cinerea*)					4–5					Hume, 1890
	monog.								2	Stuart Baker, 1929
Black Gallinule (*Gallinula chloropus*)					4					McGregor, 1909
					10–12		both			Bent, 1926
	monog.		used				both			Howard, 1940
		used		daily				19–21		Miller, 1946
				daily	5–11	1st egg	both	19–22	2–3	Witherby *et al.*, 1947

TABLE 5 (cont.)

Species	*Pairing*	*Nest ramp*	*Brood nests*	*Eggs deposited*	*Clutch size*	*Incubation*			*Number broods*	*Authority*
						Commences	*Sex*	*Period*		
Purple Gallinule (*Porphyrula martinica*)			used		6–8					Bent, 1926
Purple Reed-Hen (*Porphyrio porphyrio*)					3			23–25		Whitaker, 1899
					3–5					Dresser, 1903
Green-backed Reed-Hen (*Porphyrio madagascariensis*)					6–10					Dresser, 1903
			used							Jackson, 1938
Blue Reed-Hen (*Porphyrio poliocephalus*)					7–10					Hume, 1890
	polyg.				5–7		♂			Oliver, 1930
Takahe (*Notornis mantellii*)	monog.				1–2	last egg	♀			Smith, 1952
	monog.	used			1–2	last egg?	♀	?	1	Williams, 1950
Black Coot (*Fulica atra*)			used							Kirkman, 1912
	monog.									Stuart Baker, 1929
				daily						Ruthke, 1939
				daily		1st egg	both	23–24		Nylund, 1945
					6–9	1st egg	both	21–24	2–3	Witherby *et al.*, 1947
Red-knobbed Coot (*Fulica cristata*)				daily	8–9			21		Priest, 1934
			used		3–7					Jackson, 1938
American Coot (*Fulica americana*)	monog.	used	used	daily	4–10	1st egg	both	23–25	2	Present study
Red-gartered Coot (*Fulica armillata*)	monog.					early				Gibson, 1920
					6–7					Schmidt, 1948

[1] This table does not attempt to give a complete review of the literature concerning the breeding behavior of all the rails in the world, but it does attempt to show some aspects of the behavior of a wide range of species within the family from widely separated parts of the world.

two to four eggs of the Green-backed Reed-Hen (Jackson, 1938: 301) to a more usual number of four to seven eggs. A notable exception is the nearly extinct Takahe of temperate New Zealand, with its normal clutch of one or two eggs (Williams, 1950: 219). The South American tropical Fulicinae have clutches of five to seven eggs while the Red-knobbed Coot, of more temperate Africa, has a clutch of eight or nine eggs (Priest, 1934: 30).

The slight amount of data available suggests that rail eggs generally may be deposited in the early morning. Ruthke (1939: 143) says that eggs of the Black Coot are always laid in the morning. Walkinshaw (1937: 470) found that Virginia Rail eggs were laid between 4 and 8 a.m., and he says (1940: 176) that Sora (*Porzana carolina*) eggs are "laid during the very early hours of daylight."

Incubation.—The sharing of incubation seems to be general among many forms related to the American Coot (see table 5). However, shared incubation is not universal throughout the rail family.

Although little information is available on the length of incubation periods by each mate, Nylund (1945) found that female Black Coots devoted more time to incubation than the males did. Among the other Rallidae, only the Black Gallinule seems to have had its length of incubation shifts recorded. Howard (1940: 56) gives this period as 38 minutes, apparently for both birds, and indicates that it was of uniform duration, which is certainly not the case in the American Coot.

Observations on the incubation behavior of any of the Rallidae seem to be rare. Howard's study (1940) of the Black Gallinule relates how one mate climbed on the nest to preen and then gently forced the incubating bird off. The ceremony that the gallinules perform during a change of shifts resembles their platform activity, just as the similar activity often results in a pre-copulatory display in the American Coot.

A review of the literature on incubation in the Rallidae indicates that the 23 to 25 day period of the American Coot is about average for the Fulicinae and gallinule groups, but a little longer than most of the less aquatic rallids (see table 5).

Care and development of young.—The Black Coot parents, like those of the American Coot, divide their brood for foraging excursions and night brooding (Witherby *et al.*, 1947: 206), and prolonged parental care of young seems to be general among Rallidae. The Water-Hen or Black Gallinule parents care for their young assiduously for about 20 days but are attacking them by the time a second clutch is started on the thirty-first day (Howard, 1940: 60). Walkinshaw indicates

that young Virginia Rails (1937: 471) and young Soras (1940: 162) are brooded on the nests for several days following hatching. The hen alone cares for young Corn-Crakes early in their life, not allowing the male to assist until the fourth day, which he does continually from that time on (Kirkman, 1912: 572). Witherby *et al.* (1947) indicate that both sexes share in caring for the young for an extended period of time in the Water-Rail (*Rallus aquaticus*), Little Crake (*Porzana parva*), and Spotted Crake (*Porzana porzana*). This, according to Oliver (1930), is also true of the Spotless Crake (*Porzana tabuensis*), Weka Woodhen, Black Woodhen (*Gallirallus troglodytes*), and Blue Reed-Hen.

The Rallidae in general seem to have black downy young. The nestlings of most of the true rails are all black without any of the colorful adornments of the more coot-like forms.

Ridgway and Friedmann (1941) describe the downy young of the North American Rallidae. They note (p. 185) that the young Black Gallinule is mostly black but that the down on the chin and throat has "whitish, curly tips." The natal down of the Purple Gallinule is a step closer to the natal down of the American Coot with its head and chin "ornamented by fine hairlike filaments of silvery white" (p. 197). The downy chick of the Caribbean Coot (*Fulica caribaea*) is evidently similar to that of the American Coot (p. 222).

The young of the Black Coot develops at a rate comparable with that of the American species, and immatures of that species depart from their home areas when about 70 days of age (Cramp, 1947: 196). The downy young of the Black Coot closely resembles the young American Coot, except that it possesses slate-black tarsi and toes as compared with the greenish-gray tarsi and toes of *F. americana* (Ridgway and Friedmann, 1941: 208).

Renesting.—The Black Coot seems to renest with much the same readiness that the American Coot does. Alley and Boyd (1947: 199) record a nest in which three eggs were deposited while the first clutch was still hatching.

While few data are available, it seems probable that many of the Rallidae are double-brooded, at least among those members of the family nesting in the warmer parts of the world. If a pair of American Coots, with an incubation period about as long as any rail, can raise two broods in about 150 days, it seems reasonable to suppose that many of the species with shorter incubation periods probably do likewise. Several forms are known to do so (see table 5).

Hatching and fledging success.—Alley and Boyd (1947) give data for the Black Coot in England that compare closely with data on the

American Coot presented earlier in this paper. They studied 14 pairs of coots with a total deposition of 121 eggs. Of those, 34.7 per cent hatched and the 28 young believed to have fledged represented 23.1 per cent of the total eggs laid, or 66.7 per cent of the eggs hatched. Only 5 per cent of their eggs were infertile and only 4 per cent were abandoned. Predators, including man, took 57 per cent of the eggs while 34 per cent were lost to miscellaneous causes (swamping, knocking-out, burying, and undetermined). They indicated a final fledging success of 1.8 young per adult pair.

SUMMARY

The American Coot is probably always monogamous in its sexual behavior. Pair formation in the early spring is gradual, following a series of mutual displays. However, if one mate disappears during the nesting season, a second mate may be accepted within 48 hours. Among the resident coots with secure territories, pairing seems to be as permanent as the life of the birds or their ability to maintain a territory.

Coots breed in a habitat which contains abundant nesting material, and they use this material freely in constructing floating structures associated with breeding. These structures are bulky, and since materials seldom present a procurement problem, they are not built for permanence but must be added to repeatedly while in use. Eggs are seldom laid in more than two of the eight or nine structures usually built by a pair in the Bay area. The other structures are utilized for resting, roosting, and brooding sites.

The three types of structures built by coots—a display platform, the egg nest, and a brood nest—follow one another in a definite sequence, and breeding events can be reliably predicted by their appearance. Certain modes of construction permit the identification of a nest type even before it is placed in use.

Copulation normally, and perhaps always, takes place on a display platform. There is little or no precopulatory display or chase, and the two birds resume normal activity within two or three minutes following copulation. Copulation has been observed from 19 days preceding the laying of the first egg to the day of laying the second egg in a clutch of eight. Copulation following completion of the clutch has been observed, but it was apparently the result of abnormal circumstances.

Eggs may appear before the nest is completed and are laid daily in the very early hours of the morning. The nest is completed and lined by the time the clutch is complete. Early season clutches

averaged 9.0 eggs while second successful clutches averaged 6.4 eggs. Nine renesting attempts, either following a successful hatch or following a nest loss, averaged 7.8 eggs per clutch, ranging from four to ten eggs per clutch.

Incubation in the earliest clutches of the season may not begin until the last egg is laid, but later clutches, both first and second layings, are incubated beginning with the first or second egg. Incubation is continuous and is shared by both sexes, the male probably doing the greater share of it.

When deposition of the clutch is just beginning the female incubates all night, but otherwise the male incubates from dusk to dawn; the female always takes about a four-hour shift at dawn and then shifts of about one hour duration follow until sunset. There is, however, a great deal of variation in shift lengths from pair to pair and from day to day. The only rigid phase of the daily schedule seems to be the female's dawn shift and even that may vary as much as one-half hour in length.

The shortest incubation period recorded was in excess of 22 days and 20 hours, the longest between 25 and 26 days. The normal incubation period is about 553 hours from time of deposition until the time the chick is completely free of the egg shell and its membranes. Eggs are pipped for an average of about 36 hours preceding the hatch, and the hatch usually follows the staggered one day interval of deposition.

Young coots are quite helpless until a day or so old and require prolonged parental care. The male parent does most of the brooding during the staggered hatching period while the female brings food to the nestlings and takes the older young away to feed and brood. Later, the parents divide the brood during feeding and brooding. The parents forage with the young until they are from 20 to 30 days old. From then on the young are largely on their own.

During the first 45 days of development the young coot goes through several contrasting and conspicuous plumage changes that make it possible to date events in the breeding cycle of its parents quite accurately.

Most pairs of coots show a surprising persistence to renest. If nests are destroyed or eggs fail to hatch, a subsequent clutch is started in very short order. Renesting following nest destruction took about four days, while renesting following a successful hatch began from 20 to 56 days later.

The nesting behavior of the American Coot apparently differs very little in any respect from that of the other Fulicinae and the generally aquatic genera of gallinules. Variations from the general rallid nesting

behavior pattern are restricted to those necessitated by the physical properties of the primarily aquatic habitat of the American Coot.

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WEIGHT AND FAT DEPOSITION IN RELATION TO SPRING MIGRATION IN TRANSIENT WHITE-THROATED SPARROWS

BY ALBERT WOLFSON

INTRODUCTION

THE results of a series of observations and experiments on the regulative factors for migration in the Oregon Junco (*Junco oreganus*) led to the conclusion that spring migration was induced by a marked change in physiological state (Wolfson, 1940, 1942, 1945). The manifestations of this change included the recrudescence of the gonads, an increase in the secretory activity of the anterior pituitary, the deposition of large amounts of subcutaneous and intraperitoneal fat, and an increase in weight to a maximum. Of these manifestations, the most readily discernible and diagnostic of a readiness to migrate were the heavy deposition of fat and the concomitant increase in weight. Their significance was attested by the fact that individuals of a resident race showed neither marked variation in body weight nor heavy deposition of fat.

To ascertain whether this was true for other resident and migratory species a critical study of the weight data in the literature was made (Wolfson, 1945). The comparable data for six resident species, when interpreted in the light of the studies of the Oregon Junco, corroborated the fact that resident individuals do not show a marked increase in weight in the spring. Comparable data for four migratory species also proved to be substantiating. However the data for three of the migratory species were collected at Berkeley, California, where the initial study of the Oregon Junco was made and where winter temperatures are relatively mild. Inasmuch as the extensive data of Nice (1937, 1938) and Baldwin and Kendeigh (1938) revealed maximum weights in several species of the interior and eastern United States during the winter, but not immediately preceding spring migration, the question was raised whether eastern species, which are subjected to low temperatures in winter, differ from western species in their annual weight cycles. The only comparable data in the literature for an eastern migratory species which I interpreted as corroborative were for the Tree Sparrow (*Spizella arborea*) at Ithaca, New York (Heydweiller, 1935; Baumgartner, 1938). Data from other eastern migratory species although suggestive of confirmation were not conclusive.

To determine whether fat deposition occurs in other eastern passerine migrants, studies of weight and fat deposition in relation to migration

were undertaken at Evanston, Illinois, beginning in the spring of 1945. Of particular interest also were the weight and fat deposition of transient individuals. The weight data obtained in the original studies of migrant races of the Oregon Junco were taken primarily from winter residents. Similarly, the comparable weight data in the literature were from winter residents. There were no data to indicate the fate of the large fat deposits during the spring migratory period. This present report is confined to data for the White-throated Sparrow (*Zonotrichia albicollis*) for the three years from 1945 to 1947.

The White-throated Sparrow is a common transient at Evanston. Little is known about its route of migration (Fischer and Gill, 1946). The origin and destination of the individuals which pass through Evanston are not known, but it is not unreasonable to assume for the present that the route of migration is similar to that of other passerines in the Middle West, namely through the Mississippi Valley.

To obtain data for winter resident individuals the coöperation of Dr. Eugene Odum of Athens, Georgia, who is well situated in the wintering range of the species, was invited. The results of his studies have already been published (Odum, 1949, and Odum and Perkinson, 1951). Mrs. Louise de Kiriline Lawrence, who lives in Rutherglen, Ontario, became interested in the problem and volunteered to obtain data from the time of arrival on the breeding grounds until the time of departure in the fall. Her study is still in progress. I am indebted to Dr. Robert A. McCabe of Madison, Wisconsin, who generously turned over to me his data on body weights of White-throats captured at Madison. Miss Vera Fisher helped with the statistical analyses. It is a pleasure to acknowledge her assistance.

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METHODS

The methods employed in capturing the birds, weighing them, and determining their fat class were essentially similar to those in the earlier studies. In 1945 only two sparrow traps were available. The trapping station was set up early in April about one-hundred yards west of Lake Michigan on the campus of Northwestern University. Additional traps were available in 1946 and 1947, making a total of 3 sparrow traps and 22 Potter-style traps. The increase in the number of traps in the last two years, however, seemed to have little effect on the number of White-throats captured. The traps were

operated daily with few exceptions from early April until the end of the migratory period, about the first week of June. The daily procedure involved emptying the traps three or four times, once in the morning, once at noon, and twice in the afternoon when the birds were numerous. From the traps the birds were taken to the laboratory, and as soon as possible thereafter they were weighed and other pertinent data were obtained. The interval between the time of capture and weighing varied from one to three hours depending on the time of day. When circumstances prevented weighing them within this interval, the birds were placed in large cages with food and water until they could be examined. Careful records of the time of capture, the time of weighing, and feeding in captivity were kept for all individuals to avoid possible errors of interpretation.

All weights were taken with a Cenco balance with a sensitivity of one-tenth of a gram. After weighing, each bird was banded and the following observations were made: the amount and distribution of fat, the length of the wing, the appearance and size of the cloacal area, and the plumage of the crown, lore, throat, and breast.

To observe the fat deposits, the feathers were blown gently to expose the following regions which were examined in order: area surrounded by the wishbone (furculum), the axilla (under the shoulder joint), the lower back (synsacrum), and the abdomen. The four fat classes which were designated in the studies of the Oregon Junco (Wolfson, 1945: 109) were found to be applicable. These were "none," "little," "medium," and "heavy." In the "none class," fat is not readily visible in the regions mentioned. The best criterion of this condition is the concavity between the clavicles (furculum). When this area is deeply concave, the other regions are usually also devoid of fat. In the "little class," fat can be seen in the furculum, but usually fails to fill it completely. If it is filled completely, the clavicles are still visible. The fat is identified by its yellow color, which contrasts well with the dark or light red color of muscle. In the axilla, lower back, and abdomen small amounts of fat can also be identified. In the "medium class," the furculum is full with some covering of the clavicles; the other regions show an increased amouat with some protuberance of the skin in the axilla and lower back. In the "heavy class," the region of the furculum is swollen with fat so that the clavicles and lower neck vertebrae are completely covered. The fat literally seems to have overflowed the original hollow of the furculum. In the axilla and lower back the fat deposits protrude markedly, but by far the greatest change occurs in the abdomen. Whereas before small amounts of fat were visible and the region was normal in appearance, now it appears swollen with fat, which forms a continuous yellow layer throughout.

One of the unusual characteristics of the process of fat deposition is that the fat appears to be laid down in a definite sequence and perhaps at different rates in the regions studied. Moreover, the sequence for deposit is apparently the reverse of the sequence for utilization. The abdominal fat, which is intraperitoneal, is the first to be utilized, but the last to be deposited; that in the hollow of the furculum seems to be retained to the last, but is deposited first. The rapidity with which the products of the intraperitoneal fat could be brought to the hepatic portal circulation might conceivably be a factor in this sequence of utilization.

Since differences in sex and age are known to be correlated with body weight it was important that these be known. Nice (1932) reported that wing length proved to be a valid criterion of sex in the White-throated Sparrow. Measurements were taken in the present investigation, but were of little value for the first two years since the wings were not always measured on the day of capture. Wear in captivity made the measurements unreliable. In the third year, the sex of all birds was determined either by examination of the gonads or by the character of the cloacal area. The cloaca is an unquestionable criterion when the birds are in breeding condition, and this was reached in captivity usually within 3 weeks after capture (Wolfson, 1952). Plumage was of no value in distinguishing the sexes. In the tables the sex has been stated only for the birds captured in 1947.

Although one gains the impression from descriptions of White-throat plumages that there is an adult type, it was soon apparent from examining the plumages of spring and breeding birds and the few data in the literature, that we do not know exactly what characterizes the plumage of an "adult" White-throat. Nor do we know the sequence of plumages. On the assumption that the type of plumage of the head and breast may be correlated with age differences, the plumage of these regions was recorded. Fundamental differences were found in the crown, lore, throat, and breast. In many instances the variations occurred in specific combinations, thereby establishing definite patterns which could be easily recognized. In other cases, the mixture of characteristics defied classification. A complete analysis and discussion of the problem will be presented at a later date. For the purposes of the present paper three classes have been designated: "adult," "intermediate," and "immature." The significance of these classes is not known, but the differences in plumage were too marked to be overlooked in the analysis of the data. In the present state of our knowledge it seems likely that age differences would account for some of them, but it is also possible that sexual and racial factors are involved.

Birds classified as "adult" showed the following characteristics: crown with black lateral and white central stripes; yellow portion of superciliary stripe bright in color and extending as far back as the middle of the eye; chin, upper throat, and malar region white; lower throat and upper breast uniformly dark gray, sharply delimiting the white of the upper throat. For the "immature class" the following characteristics pertain: crown with brown lateral stripes and buffy central stripe; yellow of superciliary stripe absent, or just a tinge restricted to the region at the base of the bill; throat region light gray, separated from malar region by a prominent dusky streak; malar region flecked or barred with dusky; lower throat and breast dull buffy gray, not sharply demarcated from upper throat, often mottled or streaked

with dusky. The birds classified as "intermediate" showed numerous gradations between these two extremes. The lateral stripes of the crown, for example, were a mixture of brown and black with some tending to be predominantly black, others predominantly brown. The central crown stripe was either a buffy white or light gray with flecks of dusky. The yellow of the superciliary line was dull and restricted in extent. In many instances one could readily determine whether an intermediate bird possessed plumage more like that of the adult or immature, but in others there were no such tendencies. Birds were also placed in the intermediate group when a mixture of characteristics occurred that was not necessarily gradational. For example, the crown stripes and yellow area may have been of the adult type, but the throat and breast showed immature characteristics. This meant that the intermediate group was the most heterogeneous of the three, but at least by placing these birds together, the other two groups would in effect be more homogeneous and consequently more reliable for comparison. In the text and tables the terms adult, intermediate, and immature are listed for convenience under the heading of "age" and refer to the classes just presented.

The data were studied in two basic ways. First, variations in body weight were analyzed in relation to the date of capture. The determination of mean body weight in relation to a particular season, month, or phase in the annual cycle has been the usual approach in other studies. This method, therefore, will permit comparisons with these other studies. Second, body weight was analyzed in relation to the classes of fat deposition, sex, age (plumage types), and date of capture. This method revealed how uninformative, and occasionally misleading, a knowledge of variation in body weight alone could be.

In order to improve our understanding of the weight variations in premigratory and transient birds, it was deemed worth-while to follow the changes in body weight and fat deposition in captive birds during the winter and spring at Evanston. Accordingly, ten birds were captured during the fall migration of 1946 and were housed in small cages in an unheated room until June of 1947. A maximum and minimum thermometer was used to determine the daily range in temperature. The birds were fed unmixed canary seed, millet seed, dried insects, and dog food. Food, water, cuttlebone, and gravel were available at all times. The data for these birds have been analyzed in two ways, by actual change in weight and by percentage change.

RESULTS

Variations in Weight during the Period of Migration.—The variations in mean weight at Evanston are recorded for intervals of three days for the three years in table 1. The mean weights for the three years are remarkably similar and range from 27.1 gms. to 27.6 gms. The variation in mean weight for the individuals captured during

three-day periods are minor for the most part and irregular. The percentage differences between these means and the mean for each year are small in most cases. In some instances the differences are larger and suggest that a difference in mean weight can be expected in birds arriving at different times during the migratory period, but there does not seem to be an obvious correlation between high and low body weights and the time of migration. When fairly good numbers were trapped in a given three-day period, the mean body weight for that period tended to approach the average for the entire period of migration.

TABLE 1

MEAN WEIGHT DURING PERIOD OF MIGRATION IN WHITE-THROATED SPARROWS

Evanston, Illinois				*Madison, Wisconsin*			
	1945	*1946*	*1947*		*1943*		*1946*
Date	*Weight*	*Weight*	*Weight*	*Date*	*Weight*	*Date*	*Weight*
Apr. 25–27	26.8 (3)	——	——	——	——	Apr. 23	27.9 (18)
Apr. 28–30	27.5 (1)	——	28.1 (3)	——	——	Apr. 24	28.4 (12)
May 1–3	——	——	22.6 (3)	——	——	Apr. 25	29.5 (9)
May 4–6	——	25.9 (3)	——	May 4	28.6 (11)	Apr. 26	28.7 (9)
May 7–9	25.7 (11)	26.4 (6)	29.8 (5)	May 5	30.4 (12)	Apr. 30	28.6 (8)
May 10–12	29.6 (5)	27.9 (10)	29.1 (5)	May 6	28.9 (29)	May 1–6	29.0 (5)
May 13–15	27.3 (12)	27.7 (6)	22.7 (2)	May 7	29.4 (11)	May 7	27.9 (16)
May 16–18	30.9 (5)	26.3 (3)	31.2 (2)	May 8	26.3 (8)	——	——
May 19–21	——	——	24.0 (3)	May 9	26.6 (7)	——	——
May 22–24	——	——	27.2 (14)	May 10	29.3 (16)	——	——
May 25–27	——	——	——	May 12–14	28.9 (8)	May 13	29.5 (4)
May 28–30	——	——	24.8 (2)	May 17–19	27.7 (7)	——	——
All dates	27.6 (37)	27.1 (30)	27.1 (39)		28.7 (109)		28.5 (81)
	(Mean weight 1945–7: 27.3 (106)						

Numbers in parentheses indicate numbers of individuals.

Also in table 1 similar data are presented for birds captured at Madison, Wisconsin, in 1943 and 1946. These data also show a remarkable similarity in mean weight for the two years. The means for each day again show small variations from the overall mean.

Taking all the data into account, it seems clear that the mean weight for the entire migratory period tends to be the same each year in a given locality. The mean weight for each day, or a period of a few days, will vary, but when a good number of birds is trapped each day, the differences are small.

Variations in Weight in Relation to Fat Class, Sex, and Age.—The mean weight at the time of capture for each of the fat classes was calculated according to plumage types for 1945 and 1946 and for plumage types and sex for 1947. The numbers of individual were small in almost all categories, and for some categories no data were available. Because of this the data for the three years have been com-

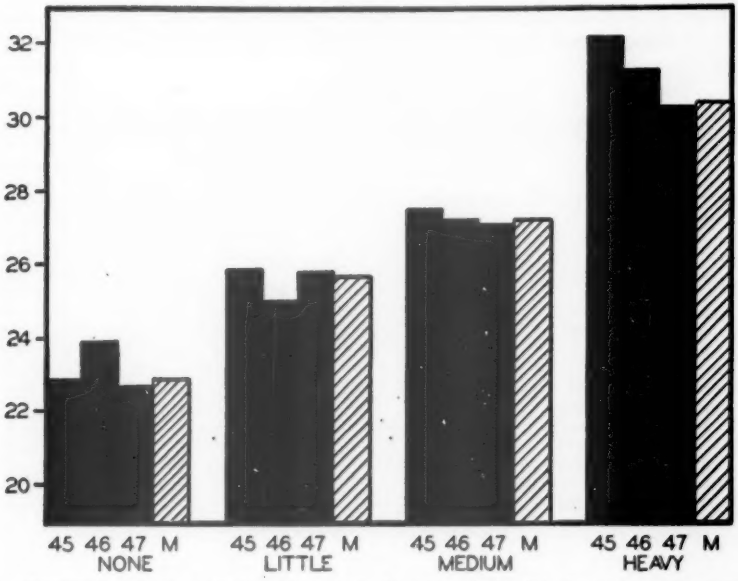

FIGURE 1. Mean weights of transients for each of the fat classes for each year and for the three-year period of study. Weights are in grams; M indicates the mean for the three-year period.

bined and are presented in tables 2 and 3 and in figure 1. In table 2 mean weight for each of the fat classes is presented. A statistical test of the difference between the means (t test) shows that the difference between all the means is significant at the 1 per cent level except the difference between the "medium" and "little" fat classes. The difference between these classes is significant at about the 5 per cent level. In actual practice these two classes are the most difficult to separate. In table 3 the weight is analyzed in relation to age for each fat class. The data show that the mean weights of all the adults and intermediates are similar in each fat class. The differences between the totals for each of these two groups and for the immatures are significantly different (1 per cent level) throughout. In the "heavy" and "medium" fat classes the differences between the same groups (adults and intermediates versus immatures) are also significant (1 per cent level). In the "little" fat class the means are similar. In the "none" fat class the numbers are too small for comparison.

Fat Classes and Plumage Types in Relation to Date of Capture.— Birds with "no," "little," "medium," or "heavy" deposits of fat can

arrive at any time during the migratory period. In 1947, when the sexes were known, the data show an earlier arrival of the males in all fat classes.

TABLE 2

MEANS AND EXTREMES OF WEIGHT OF FAT CLASSES AT TIME OF CAPTURE, 1945–1947

Year		Fat Class: Heavy	Medium	Little	None
1945	Mean	32.14 (11)	27.43 (6)	25.93 (15)	22.88 (5)
	Extremes	28.8–36.6	24.9–28.7	24.6–27.5	21.8–23.7
1946	Mean	31.24 (5)	27.15 (16)	25.04 (7)	23.90 (2)
	Extremes	30.0–32.2	23.3–31.1	23.1–26.9	22.0–25.8
1947	Mean	29.24 (22)	27.10 (4)	25.80 (5)	22.65 (8)
	Extremes	25.5–34.8	25.5–30.4	23.7–28.0	18.8–26.4
1945–47	Mean	30.34 (38)	27.20 (26)	25.67 (27)	22.89 (15)
	Extremes	25.5–36.6	23.3–31.1	23.1–28.0	18.8–26.4
Standard deviation		2.66	1.64	1.32	1.98
Standard error of mean		0.457	0.331	0.258	0.529
Percentage increase from None class—all records		32.5	18.8	12.1	—
Percentage increase from lower preceding class		11.5	6.0	12.1	—
Percentage difference from mean wt. (27.33) of all records		+11.0	−0.5	−6.1	−16.3

Numbers in parentheses indicate numbers of individuals

TABLE 3

MEAN BODY WEIGHT IN RELATION TO FAT CLASS AND AGE, 1945–1947

	Heavy			Medium			Little			None			Totals		
	Ad.	Inter.	Imm.	Ad.	Inter.	Imm.	Ad.	Inter.	Imm.	Ad.	Inter.	Imm.	Ad.	Inter.	Imm.
No.	15	14	9	11	10	5	8	11	8	7	5	3	41	40	25
Mean	30.9	31.4	27.9	27.9	27.1	25.9	25.8	26.1	25.0	22.8	24.3	20.8	27.7	27.9	25.7
S.D.	2.26	1.13	1.57	1.37	2.13	1.07	1.25	1.38	0.9	1.49	1.58	1.49	3.85	3.07	2.51
S.E.	0.60	0.31	0.55	0.43	1.46	0.54	0.47	0.44	0.37	0.61	0.79	—	0.56	0.49	0.51

The data for plumage types are presented in table 4. They show clearly a tendency for adult types to arrive first, followed by the "intermediates," with the "immatures" arriving last. There is considerable overlap, because of a sex difference to some extent, but it remains for future work to establish the sequence of migration for each sex of each plumage type.

Changes in Weight of Captive Birds.—In figure 2 the changes in weight are shown. The dates of weighing are indicated by the vertical lines, and the points on each date line represent the mean weights of the individuals in each group. There were 3 adult males, 3 immature males, and 4 immature females. The adult male group included 2 birds that were intermediate in plumage.

The data show a gradual increase in weight in the adult males from the beginning of the experiment, and on January 27 they were about

TABLE 4

FREQUENCY OF AGE TYPES DURING THE PERIOD OF MIGRATION, AT EVANSTON, 1945–1947

	Age								
	Adult			*Intermediate*			*Immature*		
Date	*1945*	*1946*	*1947*	*1945*	*1946*	*1947*	*1945*	*1946*	*1947*
Apr. 25	1	—	—	1	—	—	—	—	—
Apr. 26	—	—	—	1	—	—	—	—	—
Apr. 28	1	—	—	—	—	—	—	—	—
Apr. 29	—	—	—	—	—	1 (♂)	—	—	—
Apr. 30	—	—	2 (♂♂)	—	—	—	—	—	—
May 1	—	—	3 (♂♂)	—	—	—	—	—	—
May 6	—	—	—	—	2	—	—	1	—
May 7	—	1	—	—	—	4 (♂♂)	—	—	—
May 8	—	—	—	—	2	1 (♂)	—	—	—
May 9	5	1	—	3	2	—	3	—	—
May 10	1	—	3 (♂♂)	1	1	1 (♂)	—	—	—
May 11	—	4	—	1	1	—	—	3	—
May 12	1	1	1 (♀)	1	—	—	—	—	—
May 13	2	—	—	7	—	—	3	—	—
May 14	—	2	—	—	1	—	—	1	1 (♀)
May 15	—	—	—	—	1	1 (♂)	—	1	—
May 16	1	1	—	2	2	1 (♀)	1	—	—
May 17	—	1	1 (♀)	—	1	—	—	—	—
May 18	—	—	—	1	—	—	—	—	—
May 21	—	—	3 (♀♀)	—	—	—	—	—	2 (♀♀)
May 23	—	—	1 (♀)	—	—	—	—	—	5 (♀♀)
May 24	—	—	4 (♀♀)	—	—	—	—	—	2 (♀♀)
May 30	—	—	—	—	—	1 (♀)	—	—	1 (♀)
Totals	12	11	18 (8♂♂-10♀♀)	18	13	10 (8♂♂-2♀♀)	7	6	11 (♀♀)

6 gms. heavier than at the start. The immatures of both sexes varied slightly during this same period, and on January 27 their weights were about the same as their initial weights; from January 27 or 29 to February 8 there was a sharp increase in the weight of the males and a smaller one in that of the females. On the latter date, the males reached their maximum mean weight for the entire period of captivity —34.9 gms. for the adults, and 30.9 gms. for the immatures. The mean weight of the females reached a peak of 28.2 gms. on February 8, but this was exceeded by the premigratory peak of 29.5 gms. After February 26 the weights of all groups began to decrease gradually, and the immatures continued to lose weight until by April 30 their weights were markedly lower than the peak of February 8. From April 30 to May 16 the most marked change occurred in the immature females, which showed an average increase in weight of 6.4 gms. The immature males showed a slight increase (+ 1.7 gms.), and the adult males a slight decrease (− 2.7 gms.) From May 16 to June 10 previous weights were in general maintained. It is interesting to note that the initial mean weights of the three groups were similar and ranged from 25.7 to 26.5 gms.; the final weights were also similar and

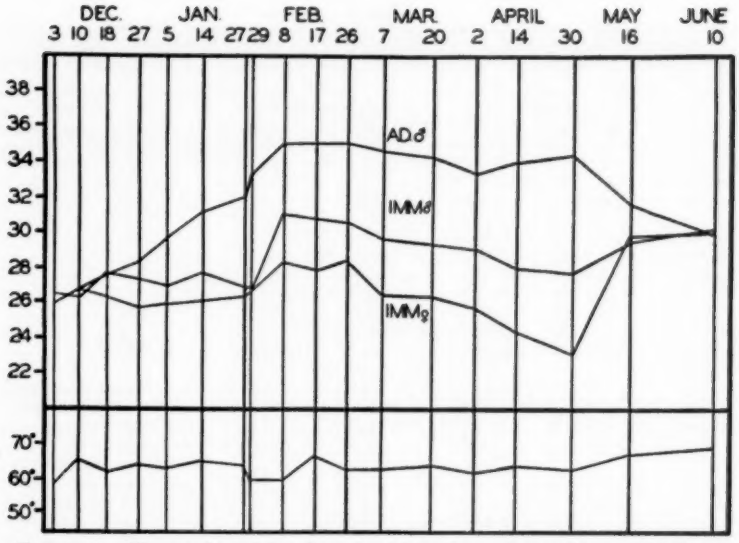

FIGURE 2. Changes in weight of captive birds, December to June. Weights are given in grams. Temperatures are in Fahrenheit and represent the average of the mean daily temperatures for the period preceding the date of weighing.

ranged from 29.9 to 30.0 gms. It was exactly the same at 29.9 gms. for the two groups of males.

When one considers the percentage change from the initial weight of December 3, it is seen that there was an increase of about 35 per cent in the adult males by February 8. An increase in the weight of a bird of about one-third of its original weight is, biologically speaking, a marked change. In this case, the increase in weight is clearly associated with a marked deposition of fat. In the immatures the changes in weight from December 3 to January 27 varied within 5 per cent of the initial weight. Judging from the many birds that we have handled in the laboratory, differences of this magnitude are well within the normal range of daily variation in captive birds, and they are not regarded as significant variations. The change from January 27 or 29 to February 8 was about 17 per cent in the immature males and 10 per cent in the immature females and is significant. The increase in the immature females from April 30 to May 16 of about 28 per cent was also significant.

In view of the fact that "mean" figures obscure the extent of response in individuals, especially in a group where variations in time of response occur, the following summary is presented. The adult

males showed the most marked increase in weight in winter: 25.9, 34.0, and 47.1 per cent. The increase in the immature males was moderate: 12.0, 18.6, and 19.1 per cent. In the immature females it was marked in one bird, 34.2 per cent, and moderate in the others, 7.1 and 19.1 per cent. Where the data permit comparisons between winter and spring increases (four birds), they show that the spring increases are higher, with one exception. The average of the per cent increases in spring for these four birds was 33.75 (range: 28.0–40.0); in the winter it was 19.87 (range: 7.1–34.2).

The observations on fat deposition in these captive birds indicate that in most cases marked changes in weight were correlated with changes in fat deposition. The major exception to this was the birds which showed excessive amounts of fat. They had so much fat that they could lose weight and fat and still remain in the "heavy" fat class.

DISCUSSION

Mean Weight before and during Migration.—The mean weight of all the White-throats captured at Evanston during the period of spring migration was 27.3 gms. For each of the three years the means were, respectively, 27.6 gms., 27.1 gms., and 27.1 gms. The means for two years at Madison, Wisconsin, were 28.7 and 28.5 gms. These data agree closely with some of the results of other investigators. Baldwin and Kendeigh (1938) report a mean of 28.7 gms. for 16 individuals in April and a mean of 29.4 gms. for 90 individuals in May. Nice (1938) reported a mean of 28.6 gms. for 35 birds captured during the spring migration. When sexes were differentiated by the size of the wing, the mean for the males was 29.4 gms. (17 birds) and for the females 26.4 gms. (18 birds). Becker and Stack (1944) found a mean weight of 27.2 ± 0.1 for 375 birds. In all of these cases the birds were transients.

Odum (1949) studied winter residents. The mean weight for the entire period of winter residency is not given, but it is given for each month and half-month for each sex. The data show that there are sex differences in weight and that there are two peaks in weight, one in midwinter and one in the spring just prior to migration. This is also shown in the record of the 10 captives herein reported. Odum's weights for each month for the males range from a low of 26.0 gms. in October to 29.8 gms. in April. The weights in grams for the months between are in order, 27.0, 27.0, 28.9, 28.7, and 28.1. The difference between March and April means is 1.7 grams. The mean weights for each month and half-month obscure the marked increase in weight which occurs in individuals just prior to migration. The greater

quantitative response in our captive birds is to be expected since we were following the same individuals. Odum was using the mean weight of a varying "population." The conditions of captivity may also be a contributing factor.

When we compare our figures for mean weight (of captive birds) with Odum's, we find that our maximum winter increase was 22.4 per cent (5.8 gms.) for all birds as compared with 11.2 per cent for his males and 10.2 per cent for his females. In Georgia, the weights began to decrease during the latter half of February, reached a minimum in the first part of March, and remained about the same through early April. In the latter half of April only the males showed a marked increase in weight, but the increase in mean weight over the first half of April was only 2.3 gms. In the males at Athens, the difference between the spring maximum and the lowest weights of October and November was 4.0 gms., or about 15 per cent. In our birds the comparable figures for all birds (using mean body weights) would be 4.1 gms. and 15.8 per cent. However, it is evident from the earlier discussion of the responses of individual captive birds, that these figures, despite their remarkable agreement, are far from an accurate measure of premigratory increase in weight. The failure to find a marked increase in weight in the females at Athens can be accounted for by the failure to retrap the birds at the proper time, or as Odum and Perkinson (1951) have suggested, by the arrival of lean, immature transients from farther south which depressed the mean weight. Our data show quite clearly that immature females are *capable* of depositing large amounts of fat in the premigratory period. It is likely that they do so in nature before migrating, but whether they do still remains to be determined on the wintering grounds. If birds are collected, however, it is obviously impossible to say whether they deposited fat before migrating.

Odum showed in his study that the winter increase in weight was correlated with changes in temperature, and he concluded ". . . that temperature is a factor, perhaps the chief one, in bringing about the winter increase." In our study the adult males began their increase in weight when the mean temperature was above 60° F. In the immatures the marked increase in weight began after a slight drop in temperature. There is certainly good reason to suspect that the winter increase in weight is stimulated by low temperatures. On the other hand, there is reason to doubt that it is the only factor involved. The birds in captivity showed remarkable increases in weight and yet the temperatures were certainly moderate. I think that the short photoperiod of winter may also be a factor.

It was found by experimentation (Kendeigh, 1934) that heavier birds had a greater resistance to low air temperature, whereas lighter birds tolerated high air temperature for a longer time. From this observation it was argued that heavier individuals of a species should arrive earlier in the spring, while in the fall the reverse should be true. Furthermore, upon analysis a relation between weight and time of migration was found for the White-throated Sparrow and the White-crowned Sparrow (*Zonotrichia leucophrys*) in the spring and in the fall at Gates Mills, Ohio. The average weight for the first half of the spring migration period was found to be greater than in the last half. In the fall the reverse was true. Although some of the differences are small and of questionable significance, there is no doubt about their existence. What is open to question, however, is the interpretation of the differences. On the basis of our studies and Odum's data it seems more likely that the higher mean weight in the first half of spring migration is due to the preponderance of males. The females, and especially the immature females, which come later, weigh less. In the fall the sequence is reversed, with the immatures migrating first. Kendeigh states (1934: 364) that no distinction was made between age and sex in analyzing the data, because it was shown that temperature resistance is not influenced by these factors. I do not mean to imply that there is no relation between body weight and temperature, but wish only to emphasize that interpretations of data on mean weight are open to question when other variables such as sex, age, fat deposition, and previous migratory behavior and expenditure of energy are not known. Similarly, when mean weights for a particular season are compared in different years to determine the effect of temperature, one must know the composition and properties of the population for each year. If one captured more adults, or more males, or more individuals that were fattening up before departure, or more lean individuals that had just arrived, the mean weight in one spring might be significantly different and correlated with differences in mean temperature. The slight differences in mean weight which have been reported by various authors could be explained by variations in treatment of birds before weighing, or by differences in the composition and properties of the population as described above.

Another weakness of calculating the mean weight for a given period of time is that it may mask or distort important information. For example, if one studied variations in weight in a winter resident population in a species in which transients also passed through the area of study and then determined the mean weight for each month,

the data might show a decrease in mean weight before the species left the area. But if the winter residents could be analyzed separately for each week, they might show an increase in mean weight before departure. The decrease shown in the analysis by months could well be due to an influx of transients and the concomitant use of too large a time unit. For example, see the discussion of Baumgartner's data on the Tree Sparrow (Wolfson, 1945: 113–115). In a similar vein, Odum missed the premigration increase in weight in the White-throat in his preliminary study because not enough individuals were obtained during the critical period of late April. Also, by averaging the weights for each month and half-month the marked increase in weight which occurs in late April was obscured.

In summary, the mean weight of a group of White-throated Sparrows (and other species) is of little dynamic value. Interpretations based on it are open to question unless other variables are known. The variables which seem to be important so far are age, sex, fat deposition, and previous migratory behavior. When calculating the mean body weight for a period of time, the best procedure is to use the smallest time unit possible. The month and half-month are usually not adequate. Analysis by days or weeks is best when the data are available.

Weight in Relation to Fat Deposition.—The ease with which transients can be segregated into fat classes, the significant differences in the mean weights of these classes, and Odum's data show clearly that fat deposition occurs in the White-throated Sparrow in relation to spring migration. Other studies (Wolfson, 1947) indicate that this fat deposition can be induced experimentally in December and January by subjecting the birds to increases in day length. The White-throated Sparrow, therefore, seems to be similar to the Oregon Junco and other species (Wolfson, 1945) with respect to fat deposition and increase in weight prior to spring migration.

The percentage differences between the various fat classes and the "none" class for all of the White-throats captured at Evanston were as follows: +12.1 for the "little" class, +18.8 for the "medium" class, and +32.5 for the "heavy" class. In the Oregon Junco and in the race *pugetensis* of the White-crowned Sparrow (Wolfson, 1945) the comparable figures (for males only) are, respectively, +5.3 and +4.5 (little class), +10.7 and +8.6 (medium class), and +18.7 and +15.3 (heavy class). The figures for the White-throat are not comparable with those for the other species since they are based on transient individuals of both sexes. The others are based on winter resident males primarily. Moreover since the lowest weights are found in

transients in the "none" class and the percentage increases are based on this figure, the increases in the White-throat are much greater than they would be if winter residents were used. The mean weight of White-throats in the "none" class which are not recent transients is about 26.0 grams. When this figure is used instead of the figure for recent arrivals, the percentage increase for the "heavy" fat class in the White-throat would be 16.5.

Blanchard (1941) determined the mean weight of various fat classes in adult male White-crowned Sparrows of the race *pugetensis*, as follows: 26.8 gms. (none), 28.0 gms. (little), 29.1 gms. (moderate), 29.3 gms. (fat), and 32.6 gms. (very fat). The difference between the "very fat" and the "none" class is +21.6 per cent. In the race *gambelii* (Blanchard and Erickson, 1949) the means of the "none" and "very fat" classes (adult males) at Davis, California, were respectively, 24.6 gms. and 27.8 gms. The percentage difference is +13.0. At Santa Barbara, California, the comparable figures are 25.7 gms., 30.1 gms., and +17.1 per cent for the same race; the increase is exaggerated by the fact that only 4 individuals were in the "very fat" class.

Odum and Perkinson (1951) did not classify their White-throated Sparrows according to fat deposits, but they determined the actual amount of fat present. The average premigration amount of fat was 16.5 per cent of the total weight, whereas in October and November, and March and early April, when there is the least amount of fat, the amount extracted was about 6 per cent of the total weight. The premigration increase, therefore, was about 10 per cent. It was higher in the males (about 12 per cent) than in the females (about 8 per cent). This percentage difference seems low when compared with the differences in weight, but the calculations are different and are not strictly comparable. If one considers only the amount of fat in the premigratory males, which was about 18.8 per cent of the total weight, and compares this with the increase in mean weight in the "heavy" class for male Oregon Juncos (+18.7) and White-crowned Sparrows (+15.3), the percentage increases are quite similar.

In summary, the amount of fat in some passerine birds can be estimated and the birds classified accordingly. By comparing them one gains a clearer picture of the changes in weight prior to and during migration than when one considers mean weight without reference to fat deposition. One can extract the fat and determine the actual amount, although I would judge from Odum and Perkinson's data and my data that observations on subcutaneous and intraperitoneal fat in relation to body weight are reliable and can be used in studies

of living birds. Sex differences have been clearly established by Odum and Odum and Perkinson. My data are confirmatory and suggest also that there are age differences.

Weight and Fat Deposition in Relation to Migration.—The real value of the data on the variations in weight and fat deposition lies in their contribution to the understanding of the regulation and conduct of migration. What happens to the heavy, premigratory fat deposits and to weight during the period of migration? On the wintering grounds at Athens, Georgia, the weights in October and November and in March and early April, when the birds show the least amount of fat, are 27.2 and 26.6 grams, respectively. These birds are probably comparable to those at Evanston which are classified as having little fat and whose mean body weight is 25.6 grams. Birds arriving at Evanston without fat have a mean weight of 22.9 gms. The difference between this mean and the mean weight before migration (31.5 grams) at Athens, Georgia, is 8.6 gms. The difference between the means of the "none" and "heavy" fat classes at Evanston is 7.4 gms. My interpretation of these data is that a White-throated Sparrow has about 8 grams of "body tissue" which can be used to provide energy for long migratory flights. If all this tissue were fat, the maximum amount of energy available would be about 72 calories. Of course, some energy would be used for maintaining normal body functions, but in a flight during one night this amount would be small compared to the amount utilized for flying. In Odum and Perkinson's determinations (1951) the average amount of fat extracted in the premigratory period was 5.2 gms. for both sexes. In the males it was 6.4 gms.; in the females it was 3.9 gms. The largest amount extracted was 7.7 gms. in a male. Taking into account the variables in the methods of extraction and determining body weights, there is remarkably good agreement in the amount of fat extracted and the maximum loss in weight observed in transients at Evanston.

If we assume that 50–70 calories are available for one flight, how far could a White-throat fly? Many factors enter into such a calculation. I have sent some specimens and data to Dr. Charles Blake who will undertake to make the calculations. However, some observations permit speculations at the present time. Siebert (1949) found that the metabolizable energy in captive White-throats in the fall was about 18 calories per bird per day, at a temperature of 22° C. and for a 15-hour photoperiod. If we assume that this represents approximately the rate for birds in the spring and that a White-throat consumes 6 to 8 grams (54–72 calories) of stored fat during a night flight of approximately 12 hours, the energy consumption would be about 6 to 8

times the normal daily requirements. Considering that not all birds arrive without fat and at the minimum weight, and other variables, I would judge this figure to be a maximum. If the arrival weight of the birds in the "little" fat class is used (25.6 grams) the energy consumed would be about 45 calories. This would be about 5 times the normal daily requirement.

Using an energy expenditure of 1.0 calories per hour at rest, and assuming a rate 6 times greater during a migratory flight at a speed of about 30 miles per hour, a White-throat would be able to fly nonstop about 9 hours on 6 grams of fat, or a distance of about 270 miles. With 8 grams of fat, a bird would be able to fly almost 12 hours or a distance of about 360 miles. These calculations are based obviously on many assumptions and do not take into account the presence of strong tail or head winds, which can modify greatly the distance traveled.

It is interesting to compare these calculations with some observations of Pearson (1950). He found that in the Allen Hummingbird (*Selasphorus sasin*) the rate of metabolism of hovering birds was about 6 times the resting rate. In the Anna Hummingbird (*Calypte anna*), it was about 5½ times the resting rate.

It is evident from our data that only a small proportion of the birds which arrive in Evanston have reached the minimum weight. During the three years the numbers of birds trapped in each fat class were: none, 15; little, 27; medium, 26; and heavy, 38. On many days a number of birds in each fat class was caught. More data at various points along the migratory route are needed, but for the present the following assumptions may be made. The birds which arrive in Evanston after a long flight during the previous night are low in weight and show little or no fat. These birds feed in the area for a day or two, or longer, depending on how long it takes to deposit a medium amount of fat or restore their weight. During this period some birds move out of the area of arrival as they forage, but they do not undertake a long flight at night. After achieving a heavy fat deposition, the birds are ready for a long flight, which takes place when the weather or other conditions provide the necessary stimulus.

In our study, the transient birds were not released after capture but were held captive to follow their weight response (Wolfson, 1954). The data from them show clearly that the birds with no fat or little fat at the time of capture gained weight rapidly, while those with medium or heavy fat deposits lost weight. The maximum gain in weight for the "none" class was about 15 per cent; the maximum loss in weight for the "heavy" class was about 25 per cent. It is also im-

portant to note that after the birds in the "none" class had reached their maximum weight in the first week in captivity, they began to lose weight. They lost eventually about 22 per cent of their maximum weight, which agrees closely with the 25 per cent loss in the "heavy" class and with the 24.4 per cent difference in weight between the birds arriving with "heavy" fat and "no" fat. Whether birds in nature will show similar responses remains to be determined. One of the great weaknesses in studying the weight and fat deposition in transient "repeats," however, is that the birds may be in the area and not be retrapped. If they are not retrapped, one would not know whether they are foraging nearby or whether they have undertaken a major flight. The weight before "departure," therefore, would be difficult to ascertain. These weaknesses can be overcome by the accumulation of many data of the type reported here and their correlation with data on time of occurrence in different localities.

Borror (1948) has analyzed the repeat records of White-throated Sparrows at Columbus, Ohio. His data suggest that non-repeating birds probably stayed more than a day. The repeating birds in the spring stayed an average of 5.3 $\pm$0.3 days. Stack and Harned (1944) report an average stop-over period of 4.5 $\pm$1.56 days at East Lansing, Michigan. In Borror's study the average per cent repeating in several spring seasons was 48.5. In Stack and Harned's study the average was 24.0. Is there any relation between stop-over time and the rate at which White-throats deposit fat? In our laboratory studies we have determined that a bird can put on as much as one gram of weight per day and advance from the "none" class to the "heavy" fat class in 4 to 6 days. When birds (White-crowned Sparrows) with heavy fat deposits were starved until their minimum weights were reached and then given food again, they restored their weights at a rate of about 2 grams per day. In three days some birds had returned to the heavy fat class. In experiments in which spring fat deposition was induced by manipulating the day length, the records for some individuals indicate that a maximum fat deposition can be achieved in four days. In one experiment the average for seven birds was 7 days $\pm$3 (Wolfson, 1953). Under natural conditions, it is difficult to determine the amount of time it takes to achieve a heavy fat deposition since the same individuals are not always captured at the right time. It is clear though from Odum's study that fat deposition occurs rapidly. He states that it "may occur within 7 to 10 days, or perhaps less," but the data presented indicate only that it occurs within the last two weeks in April and primarily between April 15 and 25 for the male population. In the White-crowned Sparrow under

natural conditions Blanchard and Erickson (1949) reported that most of the increase in fat occurs quickly within 12 days before departure.

These data on stop-over time and the amount of time required to deposit large amounts of fat are still too meagre for definitive conclusions, but when considered along with the weight data and observations on fat deposits in transients, we can begin to formulate a more precise picture of the process of migration. For example, in the White-throat, the stop-over times reported so far would be long enough to permit birds of minimum weight to restore a large part of their fat deposits. Weather conditions and available food supply would of course be important factors in regulating the rate of response. Those birds that do not repeat are perhaps those whose weights are not at a minimum on arrival. It would be interesting to see an analysis of "repeats" in terms of initial weight and fat deposition. Studies of captive White-throats (spring transients) suggest that "repeats" might be primarily birds that have no fat on arrival and are near their minimum weight.

Movements of a species during spring migration can also be correlated with data on weight and fat deposition and may yield valuable information. For example, in a coöperative study of the movements of White-throated Sparrows by the Wisconsin Society for Ornithology in 1951, Zimmerman reports (1952) that the birds seemed to move "north in a series of major impulses, 7–10 days apart, and . . . appeared to make jumps of at least 300 miles at a time." The observations on the major impulses correlate well with our observations on the time it takes to replenish fat deposits and the time it takes to deposit fat before migration.

We have no data on the ultimate fate of the fat deposits of transients in the White-throated Sparrow, but it seems likely from the data Mrs. Lawrence has obtained thus far in Ontario and from the few observations in the literature that the fat deposits are eventually lost. They are not found in breeding birds. The condition of White-throats on arrival on the breeding grounds would be interesting to know. Such information would give us a clue as to whether the breeding grounds were reached by a long final flight or by a gradual advance. Blanchard's studies of the White-crowned Sparrow (1941) indicate that the weight of recent arrivals on the br ing grounds is considerably lower than the maximum at which the started. On the wintering grounds at Berkeley the average weight of male White-crowned Sparrows which are ready to migrate, and hence have a heavy deposition of fat, is 32.6 grams. None of five males which were collected on the day of the main influx into Friday Harbor,

Washington, had any fat, and they averaged 27.1 grams in weight. Of three males collected at Vancouver, British Columbia, two had little fat and one was moderately fat, and their weights averaged 26.6 grams. The average weight of adult male winter residents at Berkeley which have no fat is 26.8 grams. The "arrival weight," therefore, seems to be equivalent to the weight of winter residents before the occurrence of fat deposition. For the Tree Sparrow, Baumgartner (1938) presents no data for birds arriving on the breeding grounds at Churchill, but she remarks that "fat tracts were still well developed in the specimens of the first week of June before breeding activities had begun." McCabe (1943) comments on the large amount of easily detachable fat on newly arriving Savannah Sparrows (*Passerculus sandwichensis*) and shrikes in the north. These observations of condition on arrival would be more meaningful if we knew whether the birds that were weighed bred in the area of arrival. The most valuable data will be obtained from birds that are banded on arrival and which are retrapped during the breeding season.

SUMMARY

White-throated Sparrows, which are transients at Evanston, Illinois, were captured during spring migration in the years from 1945 to 1947. Observations were made on weight and fat deposition, and the data were considered in relation to the process of migration.

The mean weights for each of the three years were 27.6, 27.1, and 27.1 grams, respectively. The mean weight for all records (106) was 27.3 grams. The variations in mean weight for three-day periods for the duration of migration were minor for the most part and irregular.

The mean weights of White-throated Sparrows captured at Madison, Wisconsin, in 1943 and 1946 were 28.7 and 28.5 grams, respectively. The variations from day to day, or for periods of several days, were small.

The mean weights of the fat classes into which the birds were segregated were: none, 22.9; little, 25.7; medium, 27.2; heavy, 30.3 grams. The differences between the means are significant at the 1 per cent level, except that between the "little" and "medium" classes where it is significant at about the 5 per cent level.

Birds were classified as "adults," "intermediates," and "immatures" by means of the plumage of the head and throat, but the relation between these "plumage types" and age is not definitely known. The "adults" and "intermediates" are similar in weight in each fat class, but they are significantly different from the "immatures." When the sexes were definitely known (1947), the males exceeded the

females in mean weight in all fat classes, but the numbers of individuals were too small to test the significance of the differences.

Birds with "no," "little," "medium," or "heavy" deposits of fat arrived irregularly during the migratory period. A day's catch frequently included birds from different fat classes. "Adults" tended to arrive first followed by the "intermediates," with the "immatures" arriving last, but there was considerable overlap. When the sexes were known definitely (1947), the males preceded the females.

The value of the determination of mean weight is discussed. Without consideration of variables such as sex, age, fat deposition, and previous migratory behavior, interpretations based on mean weight are shown to be open to question. It is demonstrated also that mean weight determinations can mask or distort important information.

The variations in weight which are accounted for by changes in fat deposition are summarized for several species and compared.

Data for 10 captive White-throated Sparrows demonstrate an increase in weight and in fat deposition in winter which reached a maximum in the period from February 8 to 26 and a second, premigratory peak which was reached in late May and early June; sex and age differences occurred in these increases.

The relation of the data on weight and fat deposition to migration is discussed. On the basis of several speculations and assumptions the extent of a single migratory flight of the White-throated Sparrow is estimated roughly to be between 270 and 360 miles. Data on weight and fat deposition are considered in relation to stop-over time, arrival on the breeding grounds, and other observations in the field.

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Department of Biological Sciences, Northwestern University, Evanston, Illinois, August 1, 1953.

A NESTING OF VIOLET-GREEN SWALLOWS

BY C. R. B. COMBELLACK

CHANCE observation of a pair of Violet-green Swallows (*Tachycineta thalassina*) choosing a site at our home near Eugene, Oregon, on June 8, 1951, led my husband and me to follow the whole course of the unusually late nesting. During its 47 days, I watched the nest each evening for about an hour and a half and made numerous observations and inspections at other times.

The nest box, attached to a northeast corner of the house, under wide eaves, and about 11 feet from the ground, is so constructed and situated that one can easily climb up to look into it and can observe it well from within an ell of the house. The box faces an open garden space and, beyond that, a strip of oak and Douglas fir woodland about a hundred feet away. We definitely know it was used by swallows in 1941, and every year from 1943 on; and we believe it to have been in regular use for at least 14 years. We had cleaned it out a few days before this pair of swallows chose it.

Choosing the Site, June 8.—The pair bond was apparently already formed on the morning of June 8, when the two birds were first observed, repeatedly swooping about the nest box and chattering, and landing occasionally on the roof or porch of the box. Both looked into the box from the porch. The female stood on the porch more than the male did, sometimes turning her head to look up at him on the roof of the box. Several times she went part way in, taking tiny steps forward and then backing out, each time advancing farther. Finally she went all the way in, stayed a moment or two, turned around, and then came out and flew away. The male was seen to enter once. The female's actions suggested that the choice of the nest-site itself was chiefly hers.

The male sat for a while on a dead branch of a nearby hawthorn tree and once clung to the side of the house. [Never, during subsequent observations, was he again seen in either place; he regularly perched on the box itself or on the beams or roof above, as did the female. Neither bird was ever seen to go to a nearby birdbath in the garden space before the nest.]

About 11:00 (standard time, as used in all of the succeeding account) both members of the pair were seen to come out of the box together. There were to be fewer than a dozen other times during the nesting when both birds were known to be in at once.

Nest-building, June 8 to 13.—Periods of continuous observation

began the afternoon of June 8: 1:30–2:45, 3:30–3:50, 4:00–4:42. As of 1:30, the birds were darting in unhesitatingly and silently, with building already in progress. In the 75 minutes of the first period they entered the box 13 times, presumably with nesting material, and in addition the male landed twice on the top of the box. The female left the box just after 3:30, but otherwise neither bird was seen during the second and third periods. After 4:42 we looked into the nest box. Fine-textured dry grass stems covered its floor, in a layer much thinner in one corner than elsewhere. The low place was as yet rather irregular in shape.

That evening (6:45–8:30) the birds were again much at the nest, flying up toward it, sometimes alighting momentarily, making a few brief trips in, and doing (for these usually rather silent birds) a very considerable amount of chattering. The male was not to be so often at the box again in the evening until there were young to be fed. For one period of twelve minutes, while the female sat in the box with her head out, he sat crouched on top of it, leaning forward somewhat and turning his head watchfully this way and that. [He was seen to act in this manner only once again, on the fourth evening.] The pair flew away together at 7:51.

During the second morinng (June 9) the birds did a great deal of wheeling in circles toward the nest box without entering it. The male was twice seen clinging to its porch (rather than standing on it) to look in through the entrance; this was not to be a common practice of his.

Material gathered the second day was still only grass stems or straw. By evening the layer was considerably thicker than the day before and the nest hollow deeper and rounder. In all the years that we have looked into swallows' nests in that box, the hollow has always been at the back in the same (northwest) corner. On the third day feathers were first added to the nest hollow, which was by evening about three-fourths of an inch deep and nearly three inches across. By evening of the fifth day the many feathers made it impossible to see into the cup without moving them aside, and the nest seemed essentially completed. Actually, though, the gathering of feathers and of other material continued through at least the twentieth day of the nesting (only two days before the first egg hatched). Chicken feathers were used, presumably brought from some distance since no chickens were being raised in the immediate neighborhood. The male once brought a piece of absorbent cotton too large to take through the entrance. The cotton and several chicken feathers that proved too long to be maneuvered into the box formed a litter on the

shrubbery beneath. No materials except grass stems and feathers were ever taken in.

Most of the work of gathering nesting material was done by the female. During nest-making she was observed to come to the nest box about twice as often as the male and to enter about four times as often. When he did come, it might be merely to sit on the top of the box for a moment and chatter. That he did actually bring material (later in the nesting) was indicated by the fact that he was actually seen a few times standing on the porch of the box with feathers or, once, the cotton in his beak.

The birds did not seem to gather material to any extent in the evenings but worked on the nest daily, and evidently mostly in the mornings and early afternoons. During the evening watching periods of June 9 through June 13 only four quick trips into the box might have been to bring material for the nest.

Nest-making in the mornings, the female would enter the box at irregular intervals usually a few minutes apart, sometimes staying in the box only for seconds and sometimes for a minute or two. One morning there was one interval when she stayed in the box, out of sight and so perhaps at the nest hollow in the rear, for nine and a half minutes.

Roosting.—The male never spent a night in the nest box or, so far as we know, anywhere near it. During the building period, however, he usually appeared in the evening, merely to circle, to sit for a period on the porch, or (this only once, on June 13) to enter the box briefly, chattering, after the female had gone to roost. During egg-laying, the male was observed only once at the box in the evening (on June 16) when he again went in briefly. The female roosted on the nest for 31 consecutive nights, beginning the second night after the nest was begun (see table below). The first evening of these 31 nights she went into the box at 7:44, spent much of the rest of the watching period (7:21–8:30) with her head out of the entrance hole but did not leave again. On the remaining evenings before egg-laying, she promptly disappeared for the night after entering. During the laying period, the female went to roost on June 14 and 15 about as before, but on the next two evenings she looked out and entered and left a number of times during our observations, as on subsequent evenings in the course of her incubation.

As she became progressively busier with the work of feeding, she retired later. This is shown in the following table, which gives her time of retirement for each night she slept in the box.

Date	*Hour*	*Date*	*Hour*	*Date*	*Hour*	*Date*	*Hour*	*Date*	*Hour*
June		*June*		*June*		*June*		*July*	
9	7:44	16	7:14	23	7:45	30	8:10	5	8:13
10	7:50	17	7:43	24	8:02			6	8:16
11	6:53*	18	7:49	25	8:08	*July*		7	8:16
12	6:49*	19	7:46	26	7:40	1	8:11	8	8:18
13	7:15	20	8:06	27	7:46	2	8:06	9	8:20
14	7:23	21	7:45	28	7:55	3	8:06		
15	6:56*	22	7:47	29	7:57	4	8:02		

* Before

We were interested to see what correlation might be found between time of retirement and time of sunset. From June 9 to July 9 sunset varied only a few minutes, from 7:53 to 7:59 and back to 7:56, whereas the female's latest entries into the box varied from earlier than 6:49 to 8:20: no real correlation appeared possible. Two of the three evenings when she retired before seven o'clock were cloudy, but the third was not.

Every night throughout the nesting the nest box was looked into by the light of a flashlight after dark, usually between 9:00 and 10:00. During the entire period she was observed to roost in the box, the female was always in the nest hollow. The first few nights she sat diagonally with her head right in the northwest corner. She usually was to sleep with her head thus, and never was she found facing the entrance of the box. She often seemed not to wake or notice when she was looked at.

Egg-laying, June 14 to 17.—The first egg was found in the nest at 8:20 a.m. on June 14. It had been laid sometime after 6:05 p.m. the day before. A new egg was found each morning, June 14 through June 17, and each was laid between 6:05 p.m. and 8:20 a.m. The first of the four eggs I tried to mark and in doing so broke a small hole into the air space at the large end. I returned the egg to the nest for the time but removed it a few days later; so the clutch was reduced to three.

The female spent most of the afternoon of June 14 in the nest box, but, since she sat most of the time with her head out through the entrance, she was not covering the egg. The high temperature for the day was 88°. And the next afternoon, which was nearly as hot, she spent mostly on the porch of the box. During this egg-laying period she was away much less during the daytime than she had been before, but the eggs could not have been covered much during the day. The weather continued hot. The eggs were covered at night from the first laying, as already stated.

Incubation, June 18 to 29.—During each of the twelve evening observation periods, from 7:00 to 8:30, here considered, the female made from one to five (average 2:83) trips out from the nest box. The duration of these absences ranged from 1 to 16.5 minutes, with a mean of 7.57 minutes. As she also frequently put her head out of the entrance and drew back in (ten times on the evening of June 28, for instance, besides the three times she flew out), it was apparent that in the evenings she never spent more than a few minutes at a time sitting on the eggs.

Incubation was undoubtedly done only by the female. The male was not often at the nest during this period, on eight of the twelve evenings did not approach at all, and was not seen at any time to enter the box. But he was several times seen standing on the porch with nesting material in his beak. Once he lighted on the porch when the female was inside; she put her head out; they touched beaks; and he flew: possibly he brought some small bit of nesting material which she took from him, but it rather looked as though she might be pushing him away. This incident was the only one of the sort we ever observed.

These twelve days, all clear and sunny, had highest temperatures ranging from 78° to 100°, but mostly in the 80's. Night temperatures did not drop below 45°.

Hatching, June 30 to July 1.—On the morning of June 30 the male seemed to be spending much more time than usual at the nest box. Both parents were obviously excited that day and were much about the nest, where for a time they seemed unusually sensitive to our presence. The first young swallow was hatched on June 30 between 10:14 a.m. and 1:55 p.m., and the second on the same day between 1:55 and 6:07.

As seen during the first few hours out of the shell, the young birds were doubled up perfectly quiet and unmoving, beside the remaining egg. The emptied shells were not in the nest. By 7:21 p.m. the young were moving a little. By 8:06 they had stretched their heads out, and one was sprawled over the egg. They were pink-skinned, dark only where the eyes showed through.

The third and last young one was hatched the next day, July 1, between 9:22 a.m. and 1:30 p.m. (When we looked in at 11:44 the female was sitting in the nest hollow.) The parents this time seemed not to show excitement.

Since the three remaining eggs were not marked, the shortest possible incubation period for any egg was a few hours over 13 days (June 17

to June 30); the longest possible was more than 16 days (June 15 to July 1—though it is uncertain when the female's effective incubation began). If the last-laid egg was the last to hatch, the incubation period for it was somewhat over 14 days (June 17 to July 1); and incubation of the others may have begun before it was laid.

Feeding, Brooding, and Development of Young, June 30 to July 24.—The male swallow, which so far as we knew had never spent longer than a fraction of a minute at once in the nest box, sat in it, looking out from the entrance for at least 5 minutes in the early evening of June 30. That evening's watching period showed a marked change in the birds' behavior. On the preceding evening (June 29), the male had not approached the nest, and the female had made only three trips out and back after 6:45. But on June 30 the male came 7 times after 6:45 and on 3 of those occasions went in, whereas the female went in 13 times, once with him. Presumably they were taking food in on at least some of the trips. His manner of entering was different from hers: she entered quickly, but he would stand on the porch a moment before actually going in. The afternoon and evening of July 1 both parents were making trips into the box, she more often than he. Sometimes they stayed in only momentarily; but even the male once stayed for nearly two minutes (mostly sitting at the entrance with his head out), and the female would occasionally stay out of sight, presumably at the nest hollow in the rear, for 2 to 7 minutes. Twice they were both in the box at once.

Feeding young was of course the parents' main activity during the remainder of the nesting. Presumably most of their trips into the nest were to carry food. The following table shows the number of entries each parent made during the evening watching period, plus the number of occasions, occurring during the last four evenings only, when the female fed from the porch. The time covered each evening was from approximately 7:00 until 8:30 or a few minutes later, by which time it was dark and the birds' activity had ceased. They stopped usually between 8:00 and 8:15.

	Number of trips:				*Number of trips:*				*Number of trips:*			
July	*by the male*	*by the female*	*Total*	*July*	*by the male*	*by the female*	*Total*	*July*	*by the male*	*by the female*	*Total*
2	3	12	15	9	14	23	37	16	0	29	29
3	3	13	16	10	4	23	27	17	6	22	28
4	4	16	20	11	0	31	31	18	0	28	28
5	10	22	32	12	11	24	35	19	0	18	18
6	11	38	49	13	5	33	38	20	0	17	17
7	4	37	41	14	0	27	27	21	0	9	9
8	8	40	48	15	0	30	30	22	0	17	17
								23	0	4	4

July 23 was the last evening of feeding, for the young birds flew from the nest during the next day.

It will be observed that the female was the more active. (A check showed her to be also much the more active in the morning and afternoon.) Of the total trips observed, the female made 86 per cent, and the male 14 per cent. The latter's attentiveness appears from the table to have dropped almost to nothing during the latter half of the feeding period, or from about the time the young began to leave the nest-hollow proper.

The number of evening trips into the nest box increased at first somewhat irregularly, reached its peak during the first week on July 6, and thereafter declined irregularly. The decline after July 19 was due at least in part to the fact that, during that day as we thought, one of the three young birds died of causes unknown; and so after that there were only two to be fed. The dead bird lay on the straw beside the nest hollow. We removed it.

The female covered the young for only ten nights. As long as she did so, they had seemed to sleep quietly, but when left alone they were apparently kept awake by mosquitoes. Unlike the mother, they seemed always to notice the flashlight. They were restless and jerking, and the sound of their beaks snapping could sometimes be heard even before the light was turned into the box. Mosquitoes hummed about them and were a few times seen sitting on them at night, on the still-unfeathered skin and later on their feathered backs.

On the evening of July 7, when the oldest of the brood had been out of the shell a few hours longer than seven days, the first sound was heard from the young birds. It was a faint peeping, seemingly a single note. On July 9, when nine days old, they first uttered the double note, characteristic of the young of this species, and heard especially when a parent brings food to the nest.

On the afternoon of July 15, one of the fledglings was for the first time seen out of the nest hollow when we looked into the box. It sat on the straw, facing the hollow, tail toward the entrance. Feeding must have become easier when it was no longer necessary always to take the food to the rear of the box; and indeed, beginning with a few times on July 11, the female sometimes paused for a moment, her tail still out of the box, before going on in to turn around. On July 19 one of the young ones was for the first time seen to put his head out of the entrance hole.

The afternoon of July 16, three adult swallows were fluttering about the box. One female entered and sat with her head out. Another female kept flying up to the nest; they pecked at each other; the one

in the box flew out; then both tried to enter simultaneously; then for a number of minutes they took turns flying up toward the box and hovering two or three feet in front of it, seeming to look in but making no effort to enter. Again on July 18 and 19 three, and once four, adult swallows were observed flying about the nest. We wondered if any of this activity could have been connected with the death of the one fledgling on July 19.

So far as was observed, only the female ever carried fecal sacs out of the nest box.

Both fledglings were still in the nest on the night of July 23. On July 24, the forty-seventh and last day of the nesting, feeding from the porch was going on during the morning, at least until 10:35. Sometime between then and 4:55 p.m., while the box was not under observation, the young left. The nest was still empty after dark that night. Neither the young ones nor their parents were seen any more in the neighborhood of the box.

SUMMARY

This was a late nesting of Violet-green Swallows, which began on June 8 and ended on July 24, 1951. The course of it was as follows:

June 8 (morning): Choosing the Site
June 8 to 13 (six days): Nest-building
June 14 to 17 (four days): Egg-laying (four eggs)
June 18 to 29 (twelve days): Incubation
June 30 to July 1 (two days): Hatching
June 30 to July 24 (two days plus 23): Feeding and Development of Young
July 24: Departure of Young.

The female seemed to do most of the work, including all of the incubation. The number of times the young birds were fed each evening increased at first but gradually tapered off. The female spent the second through the thirty-second nights in the nest box. When left alone at night, the young were wakeful and troubled by mosquitoes. They and the female always slept in the nest hollow. The male never spent a night at the nest.

3021 Friendly Street, Eugene, Oregon, December 31, 1952.

THE VULTURES: THEIR MOVEMENTS, ECONOMIC STATUS, AND CONTROL IN TEXAS

BY PAUL W. PARMALEE

INSTANCES in which vultures have been known to attack and devour domestic animals, particularly the young, are not uncommon. Lovell (1947) reported on the killing of young pigs by Black Vultures (*Coragyps atratus*) in Kentucky; Sprunt (1946) noted a case of predation on a lamb by this species in West Virginia; Andrews (1942) described some of the losses of lambs and ewes to Black Vultures in Burnet and Lampasas counties, Texas. Attacks by Black Vultures on wild animals such as the skunk and opossum have also been observed (McIlhenny, 1939). In the northern states where comparatively few of these birds are present, predation on livestock also occurs. Most of the damage inflicted on domestic animals is attributed to Black Vultures, with but few exceptions (Hamilton, 1941). As pointed out by Lovell (1947), however, the report by Hamilton that Turkey Vultures (*Cathartes aura*) killed young pigs near Fort Myers, Florida, may have been a "case of misidentification."

During the past ten or fifteen years, there has been an apparent increase in the amount of predation on livestock by Black Vultures, particularly in areas where cattle, hogs, and sheep are raised in large numbers. Greatest losses occur among newly-born animals and cows, ewes, and hogs during labor or shortly after birth of the offspring.

The following data are presented in an effort to represent the situation as it exists and has existed in Texas; in regard to control measures, it is neither a defense nor a condemnation of such practices.

Acknowledgements.—I am indebted to Allen J. Duvall, Fish and Wildlife Service, for band return records and other data pertaining to banding. Without the assistance and information supplied by the county agents as well as the ranchers who trapped vultures, this study would not have been possible. I also wish to express my gratitude to Mr. Allen Burgess, Route 2, Nacogdoches, Texas, for permitting me to band and use for other purposes many of the vultures that he trapped.

METHODS

In order to determine the extent of the vulture problem in Texas, letters were written to 154 county agents between August 1, 1952, and March 1, 1953. After a brief explanation of the author's interest in the problem, they were asked to submit the names and addresses of landowners in their county who had built and operated vulture traps.

Of these 154 county agents, 115 replied, and a list of names of 110 landowners was obtained.

A letter outlining the problem was then sent to each of these landowners, and included with the letter was a questionnaire regarding the trap. Questions relating to the following aspects of trapping were asked: (1) month and year the trap was built, (2) location (open pasture, woods, and woods edge), (3) approximate number of vultures caught, (4) seasonal differences, if any, in trapping success, (5) ratio of Black to Turkey vultures, (6) damage inflicted by the vultures, (7) whether trapping eliminated the vultures, (8) baits used, (9) fate of the trapped birds, and (10) capture of banded birds. Each landowner was also asked to add any additional information he felt was of interest or value.

Between August 1, 1952, and March 31, 1953, 454 Black Vultures were banded and released in Nacogdoches County, Texas, by the author. Traps in Robertson and Trinity counties were visited, although the trap and related vulture problem on the Allen Burgess Ranch, Nacogdoches County, formed the main center of study.

DATA ON TRAPPING

Of the 110 questionnaires sent to land owners who operated "buzzard" traps, 66 were filled out (more or less completely) and returned. In several instances, county agents supplied additional data in regard to past control measures in their county or in neighboring counties, and many indicated that although traps were not being used to control these birds, damage of one type or another had occurred. Loss of livestock and possible pollution of watering places by vultures led to the construction of traps in 66 counties.

Eighty-three per cent of the traps for which data are available were built after 1940. Trapping and other means of control (shooting and the use of poison) have been used for some time, one rancher (in Wharton County) stating that his grandfather had trapped vultures prior to 1900. Trapping was practiced on the King Ranch (Kleberg and Kenedy counties) as early as 1918–1919. Figure 1 shows the counties in which traps have been, or are now, in operation, Counties in which damage has resulted from depredation by vultures, but apparently not enough to warrant the building of traps, are also marked. Table 1 has been assembled from information supplied by landowners and from trap data obtained directly by the author.

Many of the ranchers who returned the questionnaire specifically indicated that the Black Vulture was the species that preyed on their livestock, and, although the Turkey Vultures would join the Blacks in feeding on the ill-gotten carcasses, they never took part in "pulling-

TABLE 1

SUMMARY OF VULTURE CONTROL MEASURES AS OF MARCH 31, 1953

	Number	*Per cent*
Location of trap (59 traps)		
Open pasture	28	(47.5)
Woods	5	(8.5)
Woods edge	26	(44.0)
Baits used (60 traps)		
Primarily dead cows, sheep, pigs and/or goats (plus young)	28	(46.7)
Armadillos and/or rabbits	17	(28.3)
Offal	9	(15.0)
Skunks, opossums, dogs, etc.	6	(10.0)
Season when the greatest number of vultures was captured (42 traps)		
Late winter and spring (February-May)	21	(50.0)
Summer (June-August)	6	(14.3)
Fall (September-October)	6	(14.3)
Early winter (November-January)	3	(7.1)
No difference noted	6	(14.3)
Damage inflicted (data from 56 landowners)		
Killed new-born calves, lambs, pigs, and/or kids	36	(64.3)
Killed new-born animals; adults in labor or shortly after giving birth; sick animals	10	(17.9)
Pollution of water	4	(7.1)
Killed livestock and pollution of water	6	(10.7)

down" stock or in killing live prey. Apparently Turkey Vultures do not have the aggressive characteristics of the Blacks.

Only ten landowners indicated that they caught more Turkey Vultures than Blacks, or about the same number of each. The author is of the opinion this is the result of two factors: first, the Black Vulture is more numerous in the eastern portions of the state than the Turkey Vulture; and, second and most important, the latter species appears to be less aggressive and more wary than the former. Although numerous Turkey Vultures were observed on many occasions flying low over the trap operated by Mr. Burgess and even alighting on it and in nearby trees, only one was captured, as compared with approximately 1,500 Black Vultures.

Approximately one-fourth of the ranchers replying to the questionnaire indicated that they kept exact records of the number of birds caught. Others gave only approximations, and several stated that "after the first 500, 1000, etc., we quit counting." The estimated figure of 100,000 vultures trapped (based primarily on questionnaire data) is without question conservative since data are probably not

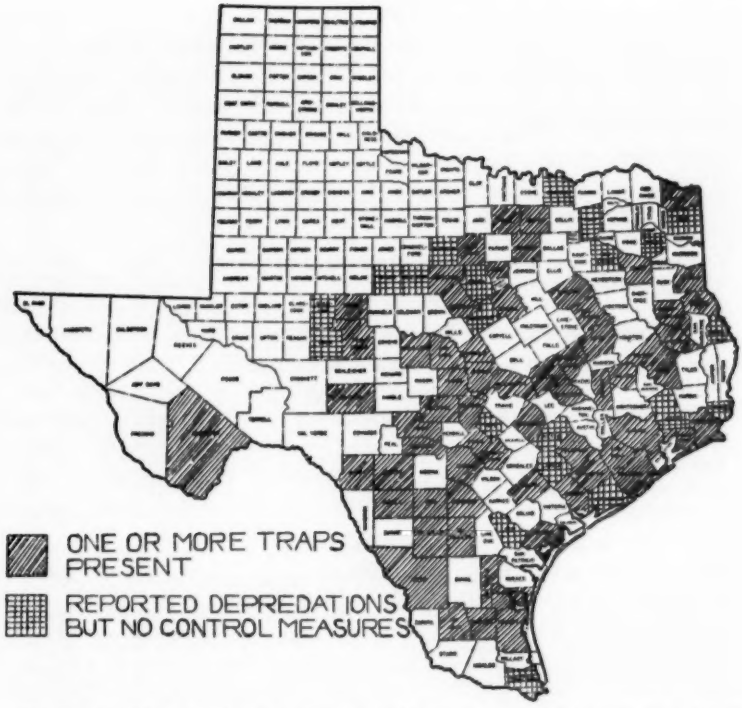
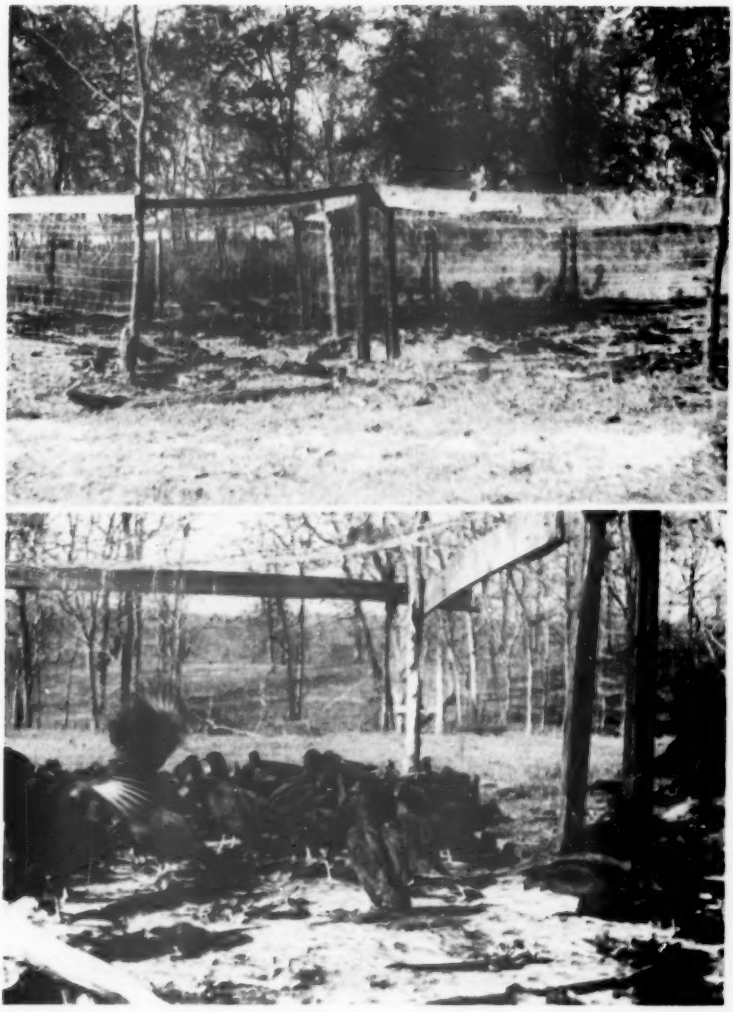


FIGURE 1. Map showing the counties in Texas where depredations by vultures are known to have occurred.

available for all traps that have been operated, and the number of birds caught after a certain number were counted was not recorded, or no count was made.

Large numbers of livestock which range over extensive areas that cannot be, or are not watched closely by their owners at the time when the young are born, constitute an easy source of food for the vultures. The greatest loss to domestic animals occurs in the newly-born and in sick or weakened animals that had difficulty giving birth. Several ranchers reported that cows or ewes, weakened from giving birth to their young and unable to defend or to clean the young or themselves of afterbirth, were often attacked (see table 1).

Vultures tend to utilize a particular local area for roosting, and traps were constructed by a few landowners for the primary purpose of eliminating those birds that were roosting on their land. The



VULTURE TRAP OPERATED BY MR. ALLEN BURGESS, NACOGDOCHES COUNTY TEXAS. (*Top*) Front view showing the V-shaped entrance. (*Bottom*) A portion of over 200 Black Vultures captured the first week in February, 1953.

majority of traps are built and retained permanently in one area, although in some cases (e.g. King Ranch, Kleberg and Kenedy counties) they are so constructed that they can be transported from one area to another. Most are roughly circular in pattern, varying in diameter (10 to 40 feet) and height (4 to 6 feet), and have a V-shaped opening through which the birds walk in (plate 1). Various types of poultry netting and stock fence are used for the sides and top. A door on one side facilitates the placing of bait and the removal of trapped birds.

Eighty-one per cent of the landowners removed the vultures (after killing them or after they died) and burned or buried the carcasses. Many indicated that by leaving a few birds, additional vultures would be decoyed into the trap. Considerable variation of opinion existed as to the most effective bait; apparently availability was the most significant factor in determining what was used. Dead livestock and offal were utilized by over 50 per cent of the trappers while armadillos and rabbits were also used by many (table 1).

Of the 52 landowners making a definite reply to the question concerning the effectiveness of their trapping efforts in eliminating the vultures, and consequently reducing the loss of domestic animals, 43 indicated that their trapping program was successful in alleviating the problem. Only four stated definitely that their attempts at eliminating the vultures were fruitless, while five were "doubtful" as to the effectiveness of such control practices. Nine ranchers noted that they trapped only periodically (all seasons represented) or until the "local population" of vultures had been caught.

Mr. L. O. Weathersbee, County Agent for Kinney County, reported that, although traps had been used with some degree of success, the most satisfactory means of control was poison. A large number of rabbits was obtained and approximately 80 cc. of a 25 per cent solution of 1080 (fluoro-acetic acid) was injected in the heart and body cavities of each dead rabbit. These rabbits, varying in number from 50 to 75, were then spread out in a circular pattern in about a one-fourth mile radius from water holes. Apparently considerable care was exercised in picking up the dead buzzards and burning them. Evidently the effectiveness of the poison bait far surpassed that of the traps and was employed to eliminate the vultures "en masse."

Ten ranchers stated their belief that vultures, by either defecating or regurgitating food, polluted watering places. Several others expressed the popular belief that these birds are transmitters of such diseases as hog cholera and anthrax. Dubos (1948) states that blood-sucking flies, dogs, rats, coyotes, "and particularly buzzards" should

be barred from diseased animals (those with or dying from anthrax) since they "probably" disseminate infectious materials, but published proof of this hypothesis in respect to vultures in wanting.

Texas has not protected the vultures since 1925, and the birds are also unprotected in the states of Delaware, Maryland, Virginia, North and South Carolina, Georgia, Florida, Alabama, Tennessee, Louisiana, and Oklahoma. Although Mississippi does protect vultures, special permits have been issued to individuals to kill these birds when they were causing damage to livestock. As indicated in personal correspondence with Alexander Sprunt, Jr. and Bayard W. Read, the vulture problem has reached such proportions in Florida that trapping has become a standard control method in certain localities.

Apparently there is a tendency for a large number of vultures to congregate in local areas where environmental conditions are particularly favorable. The number of birds occurring in the northern Panhandle and western sections of Texas is small compared to that in the central and eastern portions. Temperature may be a limiting factor during the winter months, although extensive crop farming and the absence of large numbers of domestic animals probably reduce the suitability of the region for their inhabitancy.

In the Edwards Plateau or "hill country" (south-central Texas), which is an important goat- and sheep-raising area, the loss of ewes, lambs, and kids through vulture predation has long been a serious problem. Of equal significance has been the depredation by these birds on pigs and calves in the eastern one-third of the state. Obviously one of the most important ecological factors conducive to large vulture populations is a plentiful food supply. It is reasonable to assume that, when the livestock industry (primarily cattle and sheep raising) began to expand rapidly in Texas 35 or 40 years ago, a larger source of food became available to the vultures. During the last few years there has been an apparent increase in the number of Black Vultures in a few of the southern states (especially Texas and Florida), and in local areas these birds have become quite numerous.

With the increased vulture population the "demand" for food has become greater than the "supply," and consequently the birds have turned to preying on livestock more readily. It has also been suggested (Andrews, 1952) that the efficiency of rendering companies in removing carcasses for processing soon after the animals' death, is, in a sense, competing with the vultures by removing much of their food. Fear of disease and possible epidemics have now induced most stock-owners to burn or otherwise remove carcasses of animals dying of unknown causes.

One of the most unusual situations in regard to the vulture predation problem exists on the dairy ranch of Mr. Allen Burgess at Nacogdoches, Texas. Mr. Burgess, in addition to his dairy cows, has a large number of hogs on one section of his ranch. For two consecutive springs a large percentage of newly-born pigs as well as an occasional calf were killed by Black Vultures. The number of vultures of both species that frequently congregate in large flocks on Mr. Burgess's pasture is truly astounding. On numerous occasions between 150 and 200 vultures have been observed feeding on a section of pasture of less than 50 acres.

The reason for the exceptionally large number of these birds may be attributed to a somewhat unusual agricultural practice employed by Mr. Burgess. Large quantities of chicken feathers are obtained from a local poultry house in Nacogdoches, and these are scattered on the pastures, allowed to decompose for a period of time and are then turned under for mulch. The occurrence of chicken heads and feet, mixed in with the feathers, has been the primary factor in attracting vultures to this ranch. Home butchering and the careless elimination of offal and similar waste has caused similar problems experienced by other ranchers.

In July, 1952, Mr. Burgess built a large circular trap approximately 40 feet in diameter. Over 200 Black Vultures were trapped as a result of the first baiting, and since that time (as of March 31, 1953), an average of 150 vultures a month has been captured. Most of the birds were left in the trap and soon perished from lack of food and water. Several ranchers, however, stated that they provided food and water for the few vultures they left in the trap as decoys and removed all others as soon as they were caught.

As indicated earlier in the paper, 83 per cent of the ranchers considered their trapping efforts successful in eliminating an apparently temporary local population of vultures. For most, the problem is a seasonal one (primarily at lambing and calving time), but in a case such as the one just described, the problem is ever-present. Mr. Burgess indicated that the number of vultures present now is not comparable to the number before trapping was undertaken. In all probability, many of the local birds were removed by trapping, but with such an obvious food supply of chicken remains available, additional vultures are constantly being attracted to the area. Through the coöperation of Mr. Burgess, 454 Black Vultures were banded between August 14, 1952, and March 31, 1953. It was hoped that these banded birds would give some indication of general movements and the possible stability of a population in a local area.

BANDING STUDIES

As of August 1, 1952, 22,703 Black Vultures and 1,381 Turkey Vultures had been banded in the United States, and of these totals, 899 (3.9 per cent) banded Black Vultures and 103 banded Turkey Vultures have been recovered. Only 32 of the 899 banded Black Vultures and none of the 103 Turkey Vultures were recovered in Texas. No significant returns have been recorded for the very few vultures banded in Texas prior to this study. Several thousand Black Vultures were banded at Avery Island, Louisiana, by the late E. A. McIlhenny, and 31 per cent of the total bands recovered in the United States were from these birds. Thirty-one of the 32 Texas recoveries had been banded by Mr. McIlhenny, the points of recovery all being in the eastern one-third of the state.

Ten of the 32 banded Black Vultures recovered in Texas were trapped, while the others were shot or found dead. In answer to whether any banded birds were captured in their traps, three ranchers indicated they had taken banded birds. One rancher (Wharton County) had informed the Fish and Wildlife Service of the three banded birds he had captured. The remaining two, however (Lampasas and Navarro counties), apparently did not, since no recoveries are recorded from these two counties. It is the opinion of the author, however, that in all probability numerous other banded birds have been trapped but have gone unnoticed.

As indicated previously, 81 per cent of the ranchers killed and removed the vultures, while the remaining 19 per cent left the birds in the trap. In either case, apparently little attention is given to the possibility of having caught banded birds since many of these individuals are unaware of bird-banding programs. Also, the task of removing the dead birds is unpleasant and is dispensed with as rapidly as possible, while vultures left in traps to die are given little thought. Probably many banded vultures are overlooked, since the bands soon become covered with fecal matter and would certainly go unobserved unless an individual was specifically looking for bands. Of the 454 Black Vultures banded by the author, bands on all birds that returned to the trap were covered with fecal matter. In several instances, this material had become so caked that the band was cemented to the leg.

Of the 454 banded vultures, 123 were released three and one-half miles south of Nacogdoches, a straight-line distance of approximately 10 miles from the trap, and 321 vultures were released at the trap site (four miles northeast of Nacogdoches). As of May 1, 1953, 19 (5.9 per cent) of the latter group were retrapped; 20 (16.2 per cent)

of the 123 birds released south of Nacogdoches were retrapped (banding started August 14, 1952, and ended March 31, 1953). If a local population existed, one might expect a higher percentage of recoveries from birds released at the trap than of those released some distance away, but such was not the case since approximately three times the number of birds released 10 miles from the trap returned as compared with those released at the trap.

Ten vultures were released at the east edge of Nacogdoches, and only one of these returned to the trap. These birds were released August 14, 1952, and one (Band No. 498–83926) was first retrapped March 7, 1953, and again on April 13, 1953, a time interval of 215 days between the first and second capture. A vulture wearing Band Number 498-45246 was banded August 18, 1952, and retrapped April 17, 1953; a time interval of 247 days. This interval represented the longest encountered during the study. Seven days was the shortest. The average time-interval for the 39 retrapped birds was 72 days. Only six of the 454 banded birds were retrapped twice, and no vulture was retrapped more often. McIlhenny (1937) reported catching 77 banded birds and 279 new birds at one baiting. Approximately 210 vultures represents the largest number of birds taken in Mr. Burgess's trap at one time, and seven the largest number of retrapped birds. Although banding data are limited and those which are available tend to be somewhat confusing and raise some difficult questions, a few factors are rather apparent.

The proximity of the trap to the point of release was not significant in relation to the number of retrapped birds, since the largest percentage of retraps were birds originally released 10 miles from the trap. If there was a tendency to build up a local population of vultures in that area, one would expect to retrap some of these local birds time after time, but such appeared not to be the case in this instance. As noted previously, however, 83 per cent of the landowners who trapped vultures stated definitely that trapping had eliminated local populations or at least the majority of the birds in the area. Several indicated that trapping was repeated (or seasonal) when populations of these birds again built up. When the lambing or calving season ended, and an important source of the vultures' food was gone, the few remaining local birds or occasional transients caused no problem.

The time-interval between first and second capture tends to indicate that at least some of the birds must wander over a considerable area, possibly each bird or local group having a definite territory. One bird (Band No. 498-45286) was banded and released at the trap

September 11, 1952, and was shot 2 miles east of the trap on November 11, 1952. Another vulture (Band No. 498-03619) was banded and released at the trap February 8, 1953, and was killed 10 miles north of Tyler, Smith County, Texas, two days later. This bird had moved an approximate distance of 70 miles during that two-day interval, thus indicating the relatively long distances that can be covered in a short time. A pertinent factor which could greatly influence the correct analysis of the problem is the question of whether all of the banded birds, once they come in contact with the trap again, will re-enter the trap.

Several ranchers stated that after having caught "a trap-full," a period of several days to even weeks would elapse before others would enter, even though many vultures were seen about the area. Four ranchers reported a rather unusual condition in regard to trapping success that was also noted by the author. During hot, dry periods the bait would undergo decomposition and drying without attracting vultures, until little but dried skin and bones remained. After a soaking rain, however, many new birds were caught, the only bait being the remains of the old, dried carcasses. The odor produced by the water on the dried remains of the animals used for bait apparently attracted the vultures to the trap, thus indicating the possible significance of odor in aiding vultures to locate food.

Nomadic movements or a possible territory or range of these birds may also be influenced markedly by seasonal variations and the breeding and nesting periods. It is reasonable to assume that the added pressure on the adult vulture to supply food to the young, the young requiring a considerable amount of food daily (Bent, 1937), might induce them to attack live animals more readily. Regardless of these factors, concentrations of these birds apparently become established locally when a source of food becomes available. Unfortunately this food supply has been in many instances, lambs, kids, pigs, and/or calves, and in the process of controlling vultures in Texas, a multitude of these birds have been and are now being destroyed.

SUMMARY

During the last 50 years, trapping has constituted the principal means of controlling vultures in Texas. With an apparent increase in the number of vultures during the last few years, the control program has been greatly intensified. One or more traps have been or are now being operated in each of at least 66 counties in Texas.

By writing county agents, names and addresses of landowners operating traps were obtained, and 110 of these were sent question-

naires concerning their trapping program. Sixty per cent of these landowners returned the questionnaire and data for 78+ traps were obtained.

Most, if not all, of the depredations on newly-born, sick, and weakened domestic animals is attributed to the Black Vulture.

Eighty-three per cent of the landowners stated that trapping had definitely been effective in controlling vultures and therefore preventing further depredation on their livestock. In one instance poison was used successfully to control these birds.

Between August 1, 1952, and March 31, 1953, 454 Black Vultures were banded in Nacogdoches County by the author. Although data resulting from the banding study are not complete enough to draw definite conclusions, indications are that most Black Vultures do a considerable amount of wandering. There is a tendency, however, for local concentrations to occur when a large food supply is available, and these concentration remain as long as that food supply is available.

Of the 454 vultures banded, 39 returned to the trap where they were first caught, six of these twice. One bird returned to the trap approximately eight months after it was originally banded. The possibility of some vultures becoming trap-shy after having once been captured would affect any conclusions drawn concerning their movements or status in a local population.

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Illinois State Museum, Springfield, Illinois, May 20, 1953.

IN MEMORIAM: OTTO WIDMANN

BY T. S. PALMER

OTTO WIDMANN, Fellow of the American Ornithologists' Union, authority on the birds of Missouri, careful and accurate observer, and painstaking recorder of notes, left an enviable record of accomplishments. Despite his years he never lost interest in birds or friends and serenely enjoyed the fountain of youth longer than is permitted to most men. Notwithstanding a modest and retiring nature, lack of interest in ordinary social diversions, and a disinclination to write for publication, he won for himself a position of honor and respect through a large circle of personal correspondents. Among members of the Union he was noted chiefly as the father of the social features of the annual meetings and for his penmanship, which resembled copperplate engraving.

Otto Widmann was born in Karlsruhe, Baden, Germany, on June 15, 1841, the younger son of Christoph Friedrich Widmann, 1796–1871, and Catherine Baumann, 1804–1851. His grandparents on his father's side were Christoph Heinrich Widmann, 1765–1837, and Fredricke Marie Dresch, 1753–1814; on his mother's side, Christoph Baumann, 1763–1835, and Christine Nothardt, 1766–1835. It will be noticed from these dates that he never saw any of his grandparents and that his mother died when he was only ten years of age. None of the family was remarkable for longevity. His father attained 75, his two grandfathers 72, his mother only 47, and her mother 69.

From both of his parents he inherited a love of nature which was carefully cultivated in early youth, but his love of birds was not acquired until he was over thirty. In his autobiography (Wilson Bull., 39: 146–155, 1927) Widmann describes the peculiarly favorable circumstances under which he was born and brought up. His father was connected with the management of the estate of the Grand Duke of Baden and was a nature lover and apparently an all-round naturalist, who in his early youth had collected a large herbarium, and his mother was particularly interested in gardening. Young Widmann had access to the Hofbibliotheke or private library of the Grand Duke, and one of its treasures was a copy of 'Naumann' in 12 volumes with copper-plate colored illustrations of the birds of Germany. Adjoining the library was the Naturalien-Kabinet, a small natural history museum. In the Schlossgarten could be found many live birds, and adjoining the garden were the deer park and a pheasantry where pheasants were reared. Besides these attractions was the Hardtwald or coniferous forest several miles in extent, the deciduous woods

OTTO WIDMANN, DECEMBER 6, 1921.

about the city with the foothills of the Black Forest on one side and the Rhine on the other.

As soon as he was old enough Otto was allowed to accompany his elder brother on explorations in search of birds' eggs. Other boys of the same age were also collecting and there was much rivalry to find rare specimens. "I remember well certain events," he writes, "for instance when I found quite unexpectedly the nest with four or five eggs of the Baumpieper, tree pipit. We boys were as usual somewhat scattered in going through the forest when I almost stepped on the nest from which the bird flew. It was a treasure, for it was the first ever found and the eggs were so different from all other eggs, a chocolate brown with markings of a darker color." When his father saw how interested the boys were in egg collecting, he bought them a copy of 'Little Naumann,' 'Die Naturgeschichte der Vögel Deutschlands' by C. G. Friderich, containing 200 colored illustrations of birds. He also subscribed to 'Naumannia,' the leading German ornithological journal which began publication about 1853.

At the age of 7 young Widmann entered the Lyceum at Karlsruhe, where he continued his studies for nine years. On completion of the course in April 1857, he began his training in the drug business by serving as an apprentice to a local apothecary for three years. Following this he served three more years as a clerk at Freiburg, Schwetzingen, and Neuchatel and then returned for a year's study in the Polytechnium in Karlsruhe. After his graduation in pharmacy in July 1864, two years more were spent in travel, visiting London, Paris, Berlin, Dresden, Frankfurt, Hamburg, Cologne, Antwerp, and Brussels. As a student and during the years of his apprenticeship he had little time for bird study but confined his attention to botany, chemistry, and acquiring a knowledge of French and English. But during his travels he never failed to visit the natural history museums and zoological gardens and thus maintained his interest in birds and mammals.

In March 1866, at the age of 24, he came to America and entered on a career which was destined to extend over more than an average lifetime and to bring him fame in his adopted country. On arrival he became a clerk in a drugstore in Hoboken. During the next year he worked as a clerk in Savannah and New Orleans, and finally reached St. Louis in 1867. Here he devoted his attention strictly to business, often working 16 hours a day, and finally in December 1867 became a proprietor in his business.

During this time he had little opportunity for recreation or bird study, but he mentions a few conspicuous birds with which he became

acquainted at various places, including the Redstart at Hoboken, the Cardinal at Savannah, Tree Swallows at New Orleans, Purple Martins at Vicksburg, and finally the Baltimore Oriole at St. Louis.

In 1871 he made a nine-months' trip to Europe, extending from November to the following August, and while there married Augusta Bender in Mannheim, Germany, March 5, 1872. She took great interest in his bird work and accompanied him on various trips. In 1874 she gave him for Christmas a subscription to Jasper's 'Birds of North America,' the book which was practically the beginning of his serious bird studies, and later a cane gun for collecting specimens of small birds. Mrs. Widmann was a charming woman and made friends wherever she went. For 49 years the couple enjoyed life together until her death, May 18, 1921. She accompanied him on his trips to California in 1903 and 1915 and in later years when his hearing became impaired she would often call his attention to certain warblers whose high notes he could no longer hear. After her death his daughter accompanied him to the A.O.U. meeting in Chicago in 1922.

Widmann was elected an Active Member, now known as a Fellow, of the Union in 1884. He was also a member of the National Association of Audubon Societies, the St. Louis Bird Club, and the Wilson Ornithological Club. After attending one of the early meetings of the A.O.U. he remarked that the sessions were so occupied with business and committee meetings that there was no opportunity for getting acquainted with the members or for social intercourse. This condition was soon remedied by the introduction of receptions, buffet luncheons, and the annual dinner as regular features of the meetings.

As an ornithologist Widmann was especially interested in distribution and bird migration. Most of his writings deal with the occurrence, abundance, and migration of various species. He contributed notes on migration to W. W. Cooke's 'Report on Bird Migration in the Mississippi Valley' and for a number of years regularly sent in reports on bird migration at St. Louis to the Biological Survey of the Department of Agriculture. Widmann was deeply interested in bird protection but took no active part either in legislation or enforcement. He never appeared before legislative committees or took part in game warden work. He had, however, definite and practical ideas concerning protection, such as the importance of protecting raptorial birds and the establishment of bird refuges. He never lost an opportunity to point out weak places in the game laws or the advantages of wildlife refuges. He called attention to the use of the ambiguous term 'chicken hawk,' which included useful as well as injurious species, instead of listing by name the destructive species to be excluded from

protection. In his account of the birds of Yosemite Valley, California, he emphasized the result of complete protection in the abundance of individual birds and their unusual tameness in feeding and nesting close to the porches of the hotel.

Widmann's bibliography numbered less than 50 titles. He contributed to various ornithological journals, including 'Forest and Stream,' 'Bulletin of the Nuttall Ornithological Club,' 'Auk,' 'Ornithologist and Oologist,' and 'Bird-Lore.' For about 30 years the contributions continued from 1880 to 1911, but after attaining the age of 70 apparently he ceased to write for publication. His principal works were the 'Preliminary Catalog of the Birds of Missouri,' 'The Birds of Shaw's Garden,' used as a text in the public schools, his papers on the discovery of the nest of Bachman's Warbler in the St. Francis bottoms in 1907, and the birds of Yosemite Valley, 1904, in 'The Auk,' and his Autobiography in the 'Wilson Bulletin' in 1927.

In the nineties he began work on his 'Catalog of Birds of Missouri' and had covered the land birds when the work was interrupted by a trip to Europe. He had intended to add the water birds on his return, but during his absence in 1902 his house was burned and he lost not only the manuscript but his series of diaries for 25 years. Naturally he was greatly discouraged but set to work and rewrote the book, which was published 5 years later. It was entitled a 'Preliminary Catalog of the Birds of Missouri,' as the author evidently considered it a provisional or first attempt to bring together existing knowledge concerning the birds of the state.

Widmann not only visited various parts of Missouri to familiarize himself with the native birds, but he made a number of long trips. In addition to his two European trips in 1871 and 1902, lasting nine and five months respectively, he made two trips to California, two visits to New Orleans, a trip to Wequetonsing, Michigan, in 1901, and three trips to Colorado, including two to Colorado Springs and one to Estes Park. After retiring from business in 1899, he lived at Old Orchard, Missouri, for 13 years and then returned to St. Louis where he spent his later years at 5105 Enright Ave. On November 26, 1933, he died in St. Louis, at the advanced age of 92, and was, at that time, the oldest member of the American Ornithologists' Union.

THE STRUCTURE OF THE LIVER OF BIRDS

BY JOSEPH J. HICKEY AND HANS ELIAS

THIS report is a preliminary study of the liver structure of birds. In it, 14 families were sampled. In a few previous papers, it was shown that the liver of vertebrates in general (except that in the later developmental stages of the Petromyzonidae) is a continuous mass of cells, tunneled by the lacunae hepatis in which the sinusoids are suspended (Elias, 1948; 1949a and 1949b; and Elias and Bengelsdorf, 1951 and 1952). The partitions (laminae hepatis, liver plates) between the lacunae are predominantly two-cells thick in Myxinidae, young Petromyzonidae, Selachii, Osteichthyes, Dipnoi, and Reptilia. Among the Amphibians there is a mixture of liver plates of one- and two-cell thickness within the same organ. In the Mammalia, however (that is, in all forms studied: including representatives of the Monotremata, Marsupialia, Rodentia, Artiodactyla, Perissodactyla, Carnivora, and Primates), the liver plates are always one cell thick. It has been shown that this specific mammalian liver structure provides a more stable construction from a mechanical viewpoint and that it also provides for greater physiological efficiency by increase of cell-blood contact surface and by increase of biliary outlet surface (Elias, 1952). In the same paper, the tentative suggestion was made that the change to liver walls of one-cell thickness was an important, if not indispensable, factor that allowed the rise of the mammals. This organ thus structurally improved, it was suggested, is more adequate for animals of higher metabolism and greater activity than the liver with two-cell-thick walls such as found in the lower vertebrates. In order to test this hypothesis, it became necessary to investigate the liver of the other homoeothermic class of vertebrates, namely that of the birds.

Among the vertebrates previously investigated (Elias and Bengelsdorf, 1952) there were two birds, the domestic chicken (*Gallus gallus*) showing plates of two-cell thickness and the Eastern Meadowlark (*Sturnella magna*) having uniformly one-cell-thick plates. The existence of two different kinds of liver structure in one class of vertebrates made it necessary, in order to gain insight into the avian liver in general, to extend this study to the representatives of as many different avian families as was practical.

MATERIAL AND METHODS

The material consisted of domesticated birds and trapped wild birds. The canaries (*Serinus canarius*) were supplied by Mrs. J. K.

Keizer, Mrs. Edna Becker, and Stanley Saternus of The Greater Chicago Cage and Bird Club and the germ-free chickens by James A. Reyniers of the Lobund Laboratory of the University of Notre Dame. Of the wild birds, the ducks were furnished by Frank C. Bellrose, Jr. of the Illinois Natural History Survey; the House Sparrows (*Passer domesticus*) by Karl E. Bartel of the Inland Bird Banding Association; the others largely by Robert W. Nero of the University of Wisconsin. The livers were preserved by injecting 4 per cent formaldehyde solution into the liver, either through the portal vein or the upper part of the vena cava caudalis in large birds, or by injecting the fluid directly into the body of the liver. In both kinds of procedure, most of the blood is washed out of the sinusoids by the advancing fixing fluid, and the sinusoids are distended, therewith facilitating the histological analysis of the parenchyma. Serial sections of 8 microns thickness were prepared from all specimens, but recourse to reconstruction was not made, since in the previous publications by Elias and Bengelsdorf (1951 and 1952) criteria were established by which to judge the liver structure in single sections. Long, unending rows of cells, recurrent into themselves, seen in microtome sections indicate, as was explained previously, the existence (in the three-dimensional specimen from which the section was cut) of a continuous wall work. This rule was verified in all specimens examined. The introduction of a second criterion is necessary to determine the "histological" thickness of the liver plates. By histological thickness is meant the number of cell layers constituting a wall of these plates. This criterion will be described below.

OBSERVATIONS

Plate 33 shows typical examples of the two types of livers found among birds. It is obvious from the plate that the Lapland Longspur (*Calcarius lapponicus*) possesses liver plates that are one-cell thick; but if we look at the liver of the Wood Duck (*Aix sponsa*), it is not immediately possible to decide whether the rows of cells which are two and more cells wide are normal sections of plates two or more cells thick or whether they are tangential sections of curved plates one cell thick. There are two methods by which this question can be decided without recourse to reconstruction, namely:

1. If a band-like area of liver parenchyma shows two rows of nuclei and if these nuclei are located in the middle of their respective cells, it is impossible to judge whether this particular band is a tangential or an oblique section of a plate one cell thick or whether it is a normal section of a wall two cells thick; but if in the entire specimen only very

few bands can be found which are less than two cells thick, we can conclude that most liver plates of that animal are two cells thick.

2. If the nuclei of a two-cell-wide parenchymal band are located at that side of the cells which is in contact with the blood vessels, it can be stated conclusively that this particular liver wall is two cells thick; for we can then distinguish two definite layers of cells showing a clear polarity, with a basal (paravascular) pole and a distal (intralaminar) pole.

A liver consisting of plates one cell thick shows the vast majority of plates cut at such angles that bands onecell wide result.

By means of these criteria, the histological thickness of the liver plates of all the species under investigation was determined. Plate 33 showing typical examples of each type will suffice to illustrate this paper. The specific results are listed in table 1.

DISCUSSION

In listing the orders of birds in an approximate sequence of evolutionary development (table 1), it should be stressed that the relative positions of many groups is still uncertain, and that a two-dimensional system of presentation has inherent limitations. As Mayr and Amadon (1951) point out, the Galliformes have been considered the most primitive order by one author (Portmann, 1938) and among the most primitive by another (Stresemann, 1927–34). More than one-half of the 8,600 species of birds in the world today are included in the order Passeriformes, and there is general agreement that this is the most highly developed order in the class Aves.

Although our sample is admittedly a small one, it is apparent even in this preliminary investigation that the more primitive orders and families of birds possess both types of liver structure. The passerine segment of the sample consistently displays liver plates of one-cell thickness. In this development of its liver structure, the class Aves thus is somewhat comparable to Amphibia in its possession of liver plates that are either one or two cells thick. It is further obvious that one-cell thickness is not indispensable to the attainment of a homoeothermic condition.

The presence of both types of plates in the relatively primitive Anatidae and Phasianidae studied by us appears to rule out the evolution of one-cell thickness in a phylogenetic sequence, at least in birds. For, had the evolution of liver structure among the birds proceeded in a uniform sequence together with other characters, one would expect to find liver plates two cells thick among more primitive birds like the grebes and liver plates one cell thick among higher

TABLE 1

THICKNESS OF LIVER PLATES IN BIRDS ARRANGED IN APPROXIMATE ORDER OF EVOLUTIONARY DEVELOPMENT

Order / *Family*	*Species* — *Scientific name*	*Vernacular name*	*Number of Specimens*	*Thickness of liver plate*
Colymbiformes				
Colymbidae	*Colymbus grisegena*	Holboell's Grebe	1	1 cell
Anseriformes				
Anatidae	*Anas acuta*	Pintail Duck	1	1 and 2
	Aix sponsa	Wood Duck	6	2
Galliformes				
Tetraonidae	*Bonasa umbellus*	Ruffed Grouse	3	1 and 2
	Tympanuchus cupido	Prairie Chicken	1	1
Phasianidae	*Gallus gallus*	Domestic Chicken	4	2
Gruiformes				
Rallidae	*Fulica americana*	American Coot	3	2
Passeriformes				
Alaudidae	*Eremophila alpestris*	Horned Lark	1	1
Troglodytidae	*Troglodytes aëdon*	House Wren	1	1
Mimidae	*Dumetella carolinensis*	Catbird	1	1?*
Turdidae	*Sialia sialis*	Bluebird	1	1
Sturnidae	*Sturnus vulgaris*	European Starling	2	1
Vireonidae	*Vireo olivaceus*	Red-eyed Vireo	1	1
Ploceidae	*Passer domesticus*	House Sparrow	11	1
Icteridae	*Sturnella neglecta*	Western Meadowlark	2	1
	Sturnella magna	Eastern Meadowlark	1	1
	Agelaius phoeniceus	Red-wing	1	1
Fringillidae	*Junco hyemalis*	Slate-colored Junco	1	1
	Spizella arborea	Tree Sparrow	1	1
	Calcarius lapponicus	Lapland Longspur	1	1
	Serinus canarius	Canary	8	1

* Specimen imperfectly preserved.

birds, like the Passerines. However, the most primitive bird we examined, Holboell's Grebe, has liver plates of one-cell thickness. Of the two specimens of the Pintail, one was found with walls of one-cell thickness and one with walls of two-cell thickness, while all of six Wood Ducks examined had two-cell-thick liver walls. Among the Galliformes, both types of livers are encountered: 3 specimens of the Ruffed Grouse have walls one cell thick and one specimen has walls two cells thick. The only Prairie Chicken examined had a liver consisting of plates one cell thick, while four domestic chickens had two-cell-thick liver walls. Then, 3 specimens of a bird considered to be phylogenetically more advanced, the American Coot, possessed the primitive type of liver. Only among the Passeriformes is there uniformity. Thus it is obvious that the histological thickness of liver plates among the more primitive orders of recent birds is not firmly established, but subject to specific and even to individual differences. The pressure of natural selection has produced a wide variation in the evolution of a complex of subtle characteristics that

have enabled birds to succeed in occupying a variety of ecological niches. The average heart rate in Mourning Doves (*Zenaidura macroura*) is about 135 per minute; in much smaller birds the average runs as high as 615 (Odum, 1945). The composition of muscle tissue (presence or absence of myoglobin, etc.) likewise reflects adaptiveness to environmental conditions. In with these and many other anatomical, physiological, and psychological characters, the thickness of liver plates has varied as birds evolved under the force of natural selection.

SUMMARY AND CONCLUSIONS

In 20 species of birds belonging to 5 orders, the highly developed Passeriformes (perching birds) consistently exhibited liver plates of one-cell thickness; among more primitive orders, these plates were either one or two cells thick.

Within the class of Aves, no orderly phylogenetic development of the liver structure was apparent in the 14 families studied. Histological examination of 52 specimens of these birds indicated that one-cell thickness is not a prerequisite to the attainment of a homoeothermic condition.

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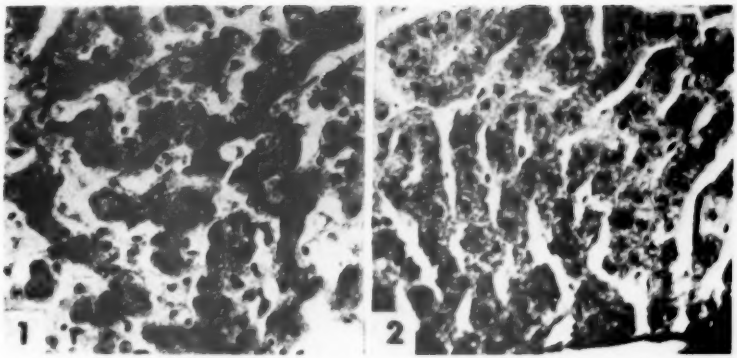

SECTIONS OF THE LIVER OF BIRDS. 8 microns, Hematoxylin and Eosin. (*1.*) Wood Duck. (*2.*) Lapland Longspur.

GENERAL NOTES

A Great Flight of Kittiwakes (*Rissa tridactyla*).—The weather was sunny and cold, with a twenty-mile wind from the north when we arrived at Halibut Point on Cape Ann, Essex County, Massachusetts, January 1, 1953. It had cleared after the previous day's northeaster, and this outlying point was chosen for the New Year's first birding in the hopes of finding pelagic birds driven near shore by the storm. Nor were we disappointed; though the Red-throated Loons (*Gavia stellata*), Red-necked Grebes (*Colymbus grisegena*), Eiders (*Somateria mollissima*), and Scoters (*Melanitta deglandi*, *M. perspicillata*, and *Oidemia nigra*) were normally few, the count of large alcids was impressive. Twenty-seven of the ninety-eight which flew by were close enough to be identified as Razor-billed Auks (*Alca torda*); in addition Dovekies (*Plautus alle*) to the number of twenty-one passed the point.

But the major flight was of Kittiwakes, which were passing in a steady stream. To count minute after minute was impossible, but a careful one-minute count was made every ten minutes. One observer, Robert Wood, acted as timer and recorder; I counted the birds within eye and binocular reach; Robert Smart using a 35× telescope concentrated on the distant birds. The flight appeared to be split; one stream of birds passed close to Halibut Point, and another half-way to the horizon; few birds were seen between the two flight lines. The Kittiwakes, whether near or far, all flew due East, going out of sight well north of the Salvages. They were moving steadily, feeding little, and passing in numbers such as we had never seen or heard of before.

From 9:30 to 10:30 the counts ran over 90 birds a minute (93 to 96) then dropped to 75-plus (78 to 83) and finally, before noon to the 30s. Soon after noon the flight practically ceased and our count ended. Carefully checked and added, these figures gave the impressive total of 11,100 *Rissa tridactyla* passing in two and a half hours.

Although Kittiwakes were not seen in such numbers on any other date, they were more than normally abundant on the Atlantic Coast. Four hundred were recorded from Cape Ann on January 4, and an estimated thousand on January 29, when over two hundred were floating in the cove just south of Halibut Point. By February, only the usual single bird or two could be found.

This great flight was foreshadowed by the unusual count of 172 Kittiwakes for the Cape Ann Christmas census on December 21; while 55 were noted on western Long Island, December 28. Of interest also is the fact that the bird was added to the Virginia state list by specimens picked up on January 3 and 18. (Audubon Field Notes, 2: 55 and 3: 204, 208, 1953.) Kittiwakes were reported by Phillips B. Street off Cape Hatteras and Kittyhawk, North Carolinia during late December and early January, and he "found them in numbers between Nassau and Havana, January 1." (Audubon Field Notes, 3: 209, 1953.)

Detailed weather reports furnished by the East Gloucester Coast Guard Station have been reviewed for the dates from December 13 to January 1. During this period the prevailing winds were largely west and northwest, moderate to strong, with none over force 6 (25 to 31 mph), and there were no unusually severe storms. There was a three-day northeaster, December 21 to 23, when the winds blew rather steadily from that quarter, force 4 to 6; again on December 31, winds were from the NNE to N, averaging force 4 (13 to 18 mph) for the day. Barometer readings on the latter date were 30.03 to 30.23, the weather overcast with some snow, but this was no major storm. There is nothing in this weather report to indicate why these masses of Kittiwakes were near land, and with the clearing weather of January 1, were steadily beating their way out to the open sea. Yet their course, as laid out

afterwards on a chart, was directly from west to east. It appeared to originate near the entrance to Plum Island Sound, or from the southern tip of Plum Island, a narrow sand spit extending south from the mouth of the Merrimac River at Newburyport to within 6.6 nautical or 7.5 statute miles of our observation point.

Gloucester fishermen, queried afterwards, could offer no suggestion as to why these gulls, which normally fish well off-shore, should have been found near land. There seems to be no explanation, unless a violent storm far out at sea was responsible for the sight witnessed that cold New Year's morning when it looked as though all the Kittiwakes in eastern North America were streaming past Halibut Point. DOROTHY E. SNYDER, *Peabody Museum, Salem, Mass.*

A Technique for Recording Rapid Consecutive Field Observations.—During a recent study of a blackbird roost, I was confronted with the problem of keeping close track of the time, light intensity, and number of each of three species entering or leaving the roost area and recording the data at the same time. It was impossible to do all this satisfactorily by myself, and I had no one on whom I felt free to call for continual assistance. A technique was developed which I felt might be of value in other types of field operations.

With the help of Mr. Don Curtis of our Audio-Visual Center a 6 volt D. C. to 110 volt A. C. inverter was rigged with a jack to fit the cigarette lighter of a car. With the car at the site for observations, a wire recorder was plugged into the inverter, a clock and light meter set in a conspicuous place, and observations dictated into the wire recorder. Later, at home, the recording was played back so that the data could be recorded on mimeographed forms. This arrangement proved of even greater value than I had anticipated. If the wire recorder had been in continuous operation during a period when a desired time check or light intensity reading had slipped by unnoticed, then it was possible afterward to construct a graph of light intensity against time from the recorded data. With such a graph, I could interpolate data in the desired units of time or light intensities. As an example, on August 11, 1952, the birds entered the roosting area "thick and fast" between 6:20 and 6:28 p.m. (E.S.T.). During this time only the following time and light readings were noted: Light 250 at 6:20; 180 at 6:28; 160 foot candles at 6:30. It was desirable to have a count of each species for the interval when the light ranged from 250 to 200 foot candles, and for the time interval from 6:20 to 6:25. From these and other recorded data a graph of light intensity against time was constructed. From this graph it was apparent that a light reading of 200 foot candles occurred at 6:26. The wire was rewound to the point on which the previous time check had been dictated in the field (6:20 p.m.). Then a clock was set at this time and the wire recorder started. The number of each species was recorded until the clock read 6:25, and the total for this time interval was taken as the number of birds entering the roosting area during the five-minute period between 6:20 and 6:25. One more minute of recording added to this gave the number of birds entering from the time the light reading was 250 foot candles until it was 200 foot candles. Had it not been for the fact that the observations were recorded on wire, the data for this and several other evenings could not have been included in the analysis.

One disadvantage in the continuous day-to-day use of this arrangement is the heavy drain on the car battery. As a consequence, the car must be operated enough to keep the battery fully charged and a close check must be kept on the water level in the battery. L. M. BARTLETT, *Department of Zoology, University of Massachusetts, Amherst, Massachusetts.*

Plumages and Territorial Behavior of the Lucifer Hummingbird in the Chisos Mountains, Texas.—In the Chisos Mountains, the first Lucifer Hummingbird (*Calothorax lucifer*) was taken by a Biological Survey party, May 7, 1901. The second report of this bird stated that "Mr. Bailey found the Lucifer hummer with several other species common in June (1901) about the big agaves which were then in full flower" (F. M. Bailey, 'Handbook of Birds of the Western United States,' 1921: 243.) A second specimen was taken May 17, 1933, while the bird was feeding on an agave in the Chisos Mountains at 5,500 feet elevation. (Van Tyne and Sutton, Misc. Publ. 37, Mus. Zool., Univ. of Mich., 1937: 43.) The third specimen, also reported by Van Tyne and Sutton, came from the edge of the Rio Grande, May 17, 1935, elevation approximately 1,800 feet. These appear to be the only published records for the area.

On May 31, 1952, I watched two Lucifer Hummingbirds for thirty minutes as they fed from agaves (*Agave scabra*) and perched in piñons (*Pinus cembroides*) just west of the Basin, Chisos Mountains, elevation about 6,000 feet. The birds, apparently a pair, were seen once the following day, but no nest could be discovered. On July 17, 1953, I observed ten Lucifer Hummingbirds along one-half mile of the South Rim, Chisos Mountains, at an elevation of about 7,500 feet. The results of these observations, obtained at the South Rim when the agaves were in full bloom, are presented below. Revisiting the same area September 11, 1953, I saw no Lucifers, and the summering species seemed to have been largely replaced by Rufous Hummingbirds (*Selasphorus rufus*).

The plumages of the birds of July 17, 1953, six males, two females, and two immatures, were similar to most accounts, however the auricular patches on the males and the plumages of the two immatures are worthy of note. The auricular areas in all six males possessed some white. This varied from a very narrow band between the throat patch and the back of the neck to a triangular patch, broadest at the base, that replaced one-third of the normal throat patch. The size of the white area appeared similar on each side of the head and remained constant in size for each individual throughout the observation time. Thus the possibility that the differences might have been the result of disordered plumage is very small. Since the size of the patch varied with each bird, individuals were best identified by this character.

The plumages of the two immatures differed from one description (Bent, 'Goatsuckers, Hummingbirds and their Allies,' U. S. Nal. Mus. Bull., 176, 1940: 431) in that their underparts were noticeably more orange-brown than those of adult females. This orange-brown wash extended from the forked tail to the throat and was heaviest on the sides. The auricular patches were cinnamon in color. The bill and even the tongue appeared dark in color. The second immature bird was somewhat lighter in the color of the underparts than the first and possessed several dark feathers forming a horizontal line in the center of the breast about in the position of the base of the throat patch of a male. This beginning of the molt of the throat feathers is about two months earlier than a similar indication of a throat patch of an immature Lucifer reported by Bent.

Territorial behavior was exhibited by most of these Lucifers, and a male feeding territory was observed for two hours. This male territory contained two agaves on the edge of the South Rim and, from them, extended to the west parallel to the cliff's edge twenty feet to a oneseed juniper (*Juniperus monosperma*), east twenty feet to an oak (probably *Quercus grisea*) and a piñon, and north fifteen feet to an alligator juniper (*Juniperus pachyphloea*), all of these low trees serving as shady perches for the defender. The center of a territory of an immature Broad-tailed Hummingbird (*Selasphorus platycercus*) was thirty feet east of this territory and the

center of a Black-chinned Hummingbird (*Archilochus alexandri*) territory sixty feet west.

Timing the actions of this Lucifer without disturbing him for three twenty-minute periods in the course of two hours, I noted time spent feeding, resting, and defending territory. All feeding was done at the two agaves, lasted from a minimum of five seconds to a maximum of twenty-one seconds, and averaged twelve seconds. He fed fifteen times per hour and occasionally uttered a quiet twittering call while feeding. Observations were made in the early afternoon. Following every feeding, if no aggressor was sighted, he would retire to sit in the shade. Once he perched after five consecutive flights without feeding. This Lucifer perched a total of forty-one minutes per hour; rests averaged one minute, but ranged from ten seconds to four minutes. Usually he would perch on one of the trees in his territory nearest the side from which he chased an aggressor. In all cases he either perched in the shade or faced away from the sun. This Lucifer defended his territory thirty-one times per hour. The trespassers were a second Lucifer (four times), several Broad-tailed Hummers, and many Black-chinned Hummers. He ignored the Red-tailed Hawks (*Buteo jamaicensis*) diving past and the many large insects that even alighted on his agaves but crouched very low when a White-throated Swift (*Aëronautes saxatalis*) passed near him. He defended his territory against any hummers that came within fifty feet of the agaves. This defense began with a chattering, and usually movement to intercept the bird, which it pursued from 20 to 100 feet from the territory. When sitting in the open occasionally he would just chatter and flutter his wings if the attacker was moving fast and apparently not stopping. Twice he failed to see a bird approaching from behind, but neither bird stopped in the territory. Once he attacked a trespasser who approached chattering but unseen, the latter being below the cliff from the Lucifer.

The eight other Lucifers fed in an area three-hundred yards in length along the cliff's edge and roughly fifty yards deep. One female, the easternmost, appeared to be in only partial possession of her area. She would drive an immature Blue-throated Hummingbird (*Lampornis clemenciae*) and Black-chinned Hummers from one agave but also would feed with some Black-chins on other agaves seventy-five feet away. At such feedings her agave would be visited by others without challenge. She remained in the area for at least two hours. The second female, two hundred yards to the west visited several undefended agaves but was driven away from one by a male Black-chin. No male Lucifer was seen near her.

The immatures remained within fifty feet of each other sitting on a wire fence or perching quietly in a piñon. Occasionally they fed on an agave but challenged neither each other nor passing Black-chins for possession of the plants.

All but two male Lucifers were defending feeding territories, areas with forty-foot radii. The first of these two fed on several agaves, sharing them with Black-chins. This first Lucifer drove the second away from an agave to their west but shared an agave to the north with the second. These two Lucifers perched within twenty feet of each other never disturbing one another in their mutual territory.

From the behavior of the two females and these last two males, it appears that there is some sharing of feeding territory within the species and even with other species. This is unlike any behavior described by Frank Bené (Mem. Boston Soc. Nat. Hist., Vol. 9, No. 3). At the same time it is noted that the other male Lucifers were exhibiting marked territorial feeding behavior. However variations are to be expected, and little information is currently available on the Lucifer Hummingbird. ROBERT P. FOX, *311 Beale Street, Quincy 70, Massachusetts.*

Cardiac and Pectoral Muscles of Trochilids.—Since hummingbirds are among the most active of birds and are able to fly at high speeds, I have been interested in determining the relative proportions of their hearts and pectoral muscles to the whole body. So far as I know little has been published on this subject. Rüppell (1931, Ornith. Monatsb., 39: 124) gives the heart and body weights of three species of trochilids, four specimens in all, three of them in captivity after being transported from Brazil to Berlin. I have determined the body weights and heart weights in several species and the weights of the pectoral musculature in a few species of trochilids. Dr. Alexander Wetmore of the Smithsonian Institution has been kind enough to identify all of the specimens.

The birds were weighed in the field on a spring balance made especially for this work (sensitivity to 0.25 gram). They were then placed in small plastic bags to prevent evaporation until reaching camp where they were weighed again on a torsion balance sensitive to 2 mg. The pectoral musculature was cut carefully away from the bone for weighing which was done on the torsion balance. After removing the pericardium, the large blood vessels were severed close to the heart, and all blood removed from the latter by means of filter paper. The hearts were weighed on a Roller-Smith torsion balance sensitive to 0.02 mg. All birds except *Archilochus colubris* were collected during January, February, and March in Panama.

Body weights were determined in 148 specimens, distributed among 25 species and subspecies. Heart weights were obtained in 84 specimens of 22 species and subspecies, and pectoral musculature weights in 13 specimens of 9 species and subspecies. Although the body weights were kept separate for the sexes, in only three species was there a difference. The significance of the difference between sexes was: for *Amazilia edward niveoventer* $P < 0.01$; for *Amazilia tzacatl tzacatl* $P < 0.01$; and for *Damophila julie panamensis* $P < 0.05$. A record was kept of the time of day at which each bird was killed. This ranged from 7 a.m. to 5 p.m. However the body weight in the same species bore no relation to this time.

Heart weights among individuals of the same species showed considerable variation in relation to the body weight (table 1). The standard errors are shown in species with more than four values. Although the standard error is usually not large, in several species the range was great because of values in a few individuals e.g, the greatest difference in extreme values was in *Selasphorus*, 1.50 to 2.86 per cent. Other examples are: *Anthracothorax*, 1.88 to 2.66 per cent; *Chlorostilbon*, 1.66 to 2.37 per cent; *Amazilia tzacatl*, 1.64 to 2.97 per cent.

Comparing species I found that except for the abnormal values, the heart ranged from 1.74 to about 2.40 per cent of the body weight. The limited number of determinations for the pectoral musculature shows the great proportion of the body found in this organ. The values range between 22.5 and 33.7 per cent in the different species and average 27.14 per cent.

Baldwin and Kendeigh (1938, Auk 55: 416–467) reported a daily rhythm of body weight, the lowest values occurring in the early morning and the greatest in the late afternoon or early evening. They attributed this to feeding. In these species where specimens were collected in the morning and afternoon I observed no such difference. However, my series was too small to be conclusive.

Rüppell (1931) reported species which were different from any of those studied by us. His heart values were somewhat higher than most of ours, being 2.265, 2.465, and 2.85 per cent. Three out of four of his specimens had been in captivity in Europe.

In a series of 300 species and subspecies of birds which I have collected, only 12

TABLE 1

CARDIAC AND PECTORAL MUSCLES OF TROCHILIDS

Form	Body weight in grams	Heart as per cent of body weight	Pectoral musculature as per cent of body weight
Glaucis hirsuta affinis	5 ♀ 6.13 ±0.32	(5) 2.27 ±0.19	(1) 27.6
	1 ♂ 6.95		
Phaethornis guy coruscus	3 ♂ 5.53; 5.72; 6.09	(3) 2.27; 2.40; 2.53	(1) 28.6
Phaethornis superciliosus cassinii	1 ♀ 6.15	(1) 2.19	
Phaethornis longuemareus saturatus	1 ♀ 2.64	(1) 2.42	
Phaeochroa cuvierii	4 ♀ 7.0; 7.5; 8.28; 9.0		
	8 ♂ 9.30 ±0.24	(6) 1.74 ±0.065	
Campylopterus hemileucurus	3 ♂ 11.2; 11.25; 13.30	(3) 1.87; 1.96; 2.01	(1) 33.7
Florisuga mellivora	2 ♀ 6.8; 7.12	(1) 1.83	
Colibri thalassinus cabanidis	1 ♀ 4.8		
	2 ♂ 5.1; 5.47	(2) 1.88; 2.01	
Anthracothorax nigricollis nigricollis	2 ♀ 7.2; 7.47	(2) 1.88; 2.66	
	2 ♂ 6.5; 7.22		
Chlorostilbon canivetii assimilis	7 ♀ 3.13 ±0.06	(8) 1.88 ±0.10	(2) 26.4; 26.5
	1 ♂ 3.03		
Damophila julie panamensis	5 ♀ 3.03 ±0.08	(5) 2.02 ±0.11	
	11 ♂ 3.35 ±0.08		
Amazilia amabilis costaricensis	3 ♀ 3.76; 3.8; 3.98	(3) 1.92; 2.05; 2.73	
	1 ♂ 4.78		
Amazilia amabilis decora	7 ♂ 4.74 ±0.14	(2) 1.87; 2.73	
Amazilia edward niveoventer	8 ♀ 4.43 ±0.08	(8) 2.28 ±0.09	(2) 27.0; 30.1
	12 ♂ 4.97 ±0.10		
Amazilia edward edward	2 ♀ 4.0; 4.3		
Amazilia tzacatl tzacatl	10 ♀ 4.72 ±0.10	(9) 2.12 ±0.08	(2) 26.3; 26.9
	12 ♂ 5.40 ±0.10		
Eupherusa eximia egregia	5 ♂ 4.35 ±0.10	(3) 2.28; 2.29; 2.46	
Elvira chionura	1 ♀ 2.83	(2) 1.92; 2.57	
	1 ♂ 2.93		
Chalybura buffonii micans	1 ♀ 5.6		
Lampornis castaneoventris	4 ♀ 4.74; 5.23; 5.5; 5.58	(6) 2.16 ±0.12	(1) 22.5
Heliodoxa jacula henryi	1 ♀ 7.39	(1) 1.98	(1) 27.9
Eugenes fulgens spectabilis	1 ♂ 5.7	(1) 2.16	
Heliothrix barroti	1 ♀ 5.7		
Archilochus colubris	3 ♀ 3.05; 3.4; 3.63	(2) 2.00; 2.62	
	2 ♂ 3.0; 3.4		
Selasphorus scintilla	9 ♀ 2.23 ±0.07	(11) 2.40 ±0.12	(2) 23.6; 25.8
	3 ♂ 2.1; 2.15; 2.75		

The number of individuals is shown in parenthesis.
Where there are more than four specimens the mean and standard error are shown.

possessed hearts 1.5 per cent or more of the body weight. From the activity of hummingbirds, the relatively greater size of the hearts might be expected.

Among the trochilids themselves, the smaller forms appear to possess relatively somewhat larger hearts than do larger forms. Thus in birds with bodies weighing between two and three grams (*Phaethornis longuemareus*, *Elvira*, and *Selasphorus*) the values were 2.42, 1.92 and 2.57, and 2.40 per cent. Birds weighing more than six grams (*Glaucis*, *Phaethornis superciliosus*, *Phaeochroa*, *Campylopterus*, *Florisuga*, *Anthracothorax*, and *Heliodoxa*) possessed hearts from 1.74 to 2.27 per cent of the body (one value of 2.66 for *Anthracothorax* may be atypical).

The relatively large pectoral musculature would indicate powerful flight and the sustained intense activity would demand more work from the trochilid heart than

that required in many other birds. Our observations show that the hummingbird has relatively the largest heart of all birds examined.

I am indebted to the Comly Fund and the Graduate School of the Ohio State University for grants in aid of this study. FRANK A. HARTMAN. *Department of Physiology, Ohio State University, Columbus, Ohio*

Food of the Great Horned Owl and Barn Owl in East Texas.—During a two year ecological study (1950–1951) of the Bob-white Quail in east-central Texas, specimens of several species of raptorial birds were collected and their stomach contents examined for remains of quail. Stomach analyses were supplemented with information obtained from 44 pellets, collected between February 22 and March 15, 1951, from three nestling and two adult Great Horned Owls (*Bubo virginianus*). The owl nest was located four miles east of Benchley, Robertson County, Texas, and was situated in the rotted crown of a large elm, the nest (the hollow crown) being approximately 35 feet from the ground.

The nest tree was one of many such elms forming a savanna in a low section of pasture. A small, permanent stream flowed between this low area and a high and drier pasture of bluestem grasses (*Andropogon* spp.). Because of the diversity of cover found in this area and the relatively high population of quail, a 640-acre section had been designated in January, 1950, as a research area for the study of quail activity and movement.

TABLE 1

ANALYSES OF 44 GREAT HORNED OWL PELLETS

Species of prey	*Number of Individuals*
Sylvilagus sp. (rabbit)	10
Sigmodon hispidus (Cotton Rat)	17
Reithrodontomys sp. (Harvest Mouse)	1
Glaucomys volans (Flying Squirrel)	1
Rattus norvegicus (Norway Rat)	1
Colinus virginianus (Bobwhite Quail)	1
Colaptes auratus (Flicker)	1
Fringillidae (sparrows)	2

Although the severe drought of the previous summer and fall had seriously affected pastureland and reduced much of the natural ground cover, cotton rats and cottontail rabbits remained plentiful. The cottontail was especially numerous in the brush, tall grass, and weeds that bordered the stream. Based primarily on skull identification, a qualitative analysis of each pellet was made to determine the species preyed upon and the frequency with which each occurred (table 1). Although cotton rats were taken in the greatest number, *Sylvilagus* sp. constituted the main bulk in the diet. Three other species of mammals and three species of birds were also consumed, but they were apparently taken incidentally rather than forming a major food item. The Bob-white was identified by the presence of leg band No. 45125 in one of the pellets; the quail had been banded on December 2, 1950, at the edge of a stretchberry thicket (*Smilax bona-nox*), approximately 100 yards from the nest tree. Prey species taken by this family of owls appeared to show a close correlation between consumption and availability.

On December 5, 1952, 375 complete pellets and portions of 80 other pellets of the

Barn Owl (*Tyto alba*) were removed from the attic of the courthouse building at Carthage, Panola County, Texas. The owls gained entrance to the attic through two circular windows at either end of the building, and from the available information, they had roosted and nested there for several years.

Analyses of these pellets (table 2) were of particular interest since the species of rodents consumed in the greatest number must have been obtained some distance from the city. *Sigmodon* is normally found in rather open, grassy pastures or in semibrushy areas, as is the pine vole. Rodents that might be expected to be taken in considerable numbers by city-dwelling owls, especially members of the Muridae, were numerically few.

TABLE 2

ANALYSES OF APPROXIMATELY 455 BARN OWL PELLETS

Species of prey	*Total Number of Individuals*
Scalopus aquaticus (Eastern Mole)	2
Cryptotis parva (Least Shrew)	48
Blarina brevicauda (Shorttail Shrew)	6
Geomys breviceps (Plains Pocket Gopher)	11
Perognathus hispidus (Hispid Pocket Mouse)	17
Reithrodontomys sp. (Harvest Mouse)	18
Sigmodon hispidus (Cotton Rat)	205
Microtus (*Pitymys*) *pinetorum* (Pine Vole)	172
Rattus norvegicus (Norway Rat)	2
Mus musculus (House Mouse)	4
Sylvilagus sp. (rabbit)	4
Caprimulgidae (goatsuckers)	3
Icteridae (blackbirds)	2
Sturnella neglecta (Western Meadowlark)	2
Fringillidae (sparrows)	14

The least shrew was taken in considerable numbers, with the shorttail shrew and common mole also represented. The occurrence of insectivores, particularly shrews, in the diet of Barn Owls is not uncommon as reported by Latham (Penna. Game Comm., P-R Proj. 36-R: 30–33, 1950) and others. At least five species of birds were noted, sparrows being the most numerous.

As indicated by the majority of prey species encountered in the Barn Owl pellets, a considerable distance must have been covered while foraging for food. Of particular significance is the large number of *Microtus pinetorum* taken by this owl, since records of this rodent in Texas are relatively few.

For several years Barn Owls had roosted in the attics of various campus buildings of the Rice Institute, Houston, Harris County, Texas. However, recent construction of additional buildings and the football stadium parking lot eliminated large open fields that had served as hunting grounds for these owls. With the source of food supply gone, the owls have almost completely disappeared from the Rice Campus. On December 23, 1952, 92 rodent skulls (from remains of old pellets) were collected from the attic of the chemistry building, of which 88 (95 per cent) were cotton rats and four (5 per cent) were Norway rats. The cotton rat is normally a common rodent in open pastures and semi-brushy areas and often forms an important constituent in the diet of raptorial birds, as noted in the case of the Great Horned and Barn owls in East Texas.—PAUL W. PARMALEE, *Illinois State Museum, Springfield, Illinois.*

Another Hybrid *Zonotrichia albicollis* × *Junco hyemalis*.—On October 8, 1953, an anomalous sparrow was captured at the banding station of Mr. Marshall Field at St. Thomas, Ontario. Through the kindness of Mrs. Lucie McDougall the bird was brought to the Museum, both of these bird-banders having recognized the desirability of preserving it as a specimen.

It is unnecessary to describe the specimen in complete detail since it corresponds closely to the specimen described by Townsend (Bull. Nuttall. Ornith. Club, 8: 78–80), commented on by J. A. Allen therein, and further elaborated on by Stone (Auk 10: 213–214) including a colored illustration by Ernest Thompson (Plate VI). The present specimen is a female, approximately three to four months old (age based on the thin, transparent skull and the breeding period of the species concerned in the northeastern portion of their ranges). The specimen recorded by Townsend (*loc. cit.*) was a male with no estimated age given.

The specimen here recorded corresponds closely in size to specimens of *Junco hyemalis* of corresponding age. Its measurements are as follows: total length, 152 mm.; wing spread, 217 mm.; chord of wing, 72 mm.; tail, 65 mm.; chord from nostril anterior to tip of bill, 7.5 mm.; tarsus, 30 mm.; weight, 16 gms. The culmen is faintly ridged. The seventh primary is longest and the ninth is approximately equal to the fourth. The tail termination is double rounded. Through direct comparison it is obvious that the portion of the skeleton of the St. Thomas specimen which was preserved is less robust than the skeleton of an immature female *Zonotrichia albicollis*, more like the skeleton of an immature female *Junco hyemalis*.

The color of the bill in life was YRY 7/2 (Munsell Book of Color) with the base and tip of the upper mandible somewhat darker. The tarsi were YRY 7/4, the toes darker. The irides were dark brown. The outer tail feathers are off-white on the outer web, and nearly the terminal half of the inner web is the same. The second pair inward has an elongated terminal whitish spot on the inner web, and the third pair inward has a much reduced terminal spot. All tail feathers have pale outer borders when viewed dorsally, the central pair being so marked with rusty brown.

Making direct comparisons with Thompson's plate (Stone, *loc. cit.*) and recalling that it represents a male and the present specimen a female, it can be seen that the median stripe on the head is more vague and washed with brown. The superciliary line is similar, but the anterior termination above the lore is dull yellow. The back and wing are practically identical with the plate, the noteworthy feature of both being a complete absence of contrasting pale streaks on the feathers of the back. The breast band is paler in value than the gray shown on Thompson's plate. There is a vague tendency toward streaking on the flanks. L. L. Snyder, *Royal Ontario Museum of Zoology and Palaeontology, Toronto, Ontario.*

A Case of Bird-eating by the Cowbird (*Molothrus ater*).—On October 17, 1952, many passerine birds sought rest aboard the research vessel Caryn of the Woods Hole Oceanographic Institution. This was a day of strong northerly winds. During the late afternoon an unidentified wren was observed on the deck of the Caryn and, several feet away, a pair of Cowbirds. At this time the Caryn was about 40 miles south of No Man's Land, Massachusetts (40° 40′ N., 71° 10′ W.). All birds were in good condition although the wren appeared to be fatigued. No further notice of these birds was taken until some time later when the Cowbirds were observed to be disputing possession of the wren, which they had apparently killed and now was a partially-eaten mass of feathers and entrails. Richard H. Backus, *Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.*

Symbiotic Feeding of Snowy Egrets with Cattle.—The remarkable symbiosis between Cattle Egrets (*Bubulcus ibis*) and the larger hoofed mammals, both domestic and wild, has long been common knowledge. However the fact that a similar relationship exists between Snowy Egrets (*Leucophoyx thula*) and domestic cattle seems to be unrecorded in ornithological literature.

Here in Florida, Snowy Egrets regularly consort with grazing cattle while feeding. This trait I have noticed repeatedly in the region around Gainesville, and it is also very conspicuous in the cattle-raising district along the west and south shores of Lake Okeechobee. In these areas almost every herd of cattle is accompanied by flocks of egrets.

The relationship between the birds and the cattle is a particularly close one. In the Gainesville area I have spent many hours watching them in order to learn something of the nature of the association. The attraction for the egrets is obviously the insects—apparently mostly grasshoppers (Acrididae and Tettigoniidae)—which the cattle frighten from the grass as they walk and graze.

Usually one to three egrets accompany each cow, although I have seen as many as seven and eight. When a cow is grazing, the egrets often take a waiting stance in front of or beside the cow's head, facing it, with their beaks six inches to a foot from the cow's muzzle. Another frequent position is immediately beside the fore- or hindlegs, or underneath the cow's belly behind the forelegs. The cattle seem completely indifferent towards the egrets, and when they move, the birds are often hard-pressed to avoid being stepped on. Cattle Egrets have been reported perching on the backs of cattle, a habit I have not observed in Snowy Egrets, due perhaps to the presence of fenceposts on which they frequently perch.

When an insect is flushed by a grazing cow, the egret either catches it on the wing or grabs it as soon as it lands. On a few occasions I have seen egrets pick grasshoppers from the sides of cows.

While many Snowy Egrets enter into this commensalism, it is purely facultative. On Payne's Prairie, a 13,000-acre wet prairie south of Gainesville, each large herd of cattle may be accompanied by hundreds of egrets, yet there are as many or more egrets feeding in the nearby sloughs and marshes away from cattle.

There seems to be some daily and seasonal variation in the extent of this association. It is more frequent in mid-morning (8:00 to 11:00 A.M.) and late afternoon (3:00 to 5:00 P.M.), corresponding with the periods of most active grazing. If a cow stops grazing and lies down, its accompanying egrets immediately stalk off to another cow. In North Florida at least, the habit is more frequent in late summer and drops off during the winter, a fact doubtless correlated with the abundance of insects.

Several interesting questions arise concerning this symbiosis. Is it mutualistic, or merely commensalistic? Information on Cattle Egrets indicates that they occasionally pick ectoparasites from the cattle. I have not observed Snowy Egrets doing this; lack of severe tick infestations could be a factor, but I do not believe egrets would deliberately search for such small prey. I have seen them pick grasshoppers from cattle, and they may take biting flies (Tabanidae) in the same manner.

Another possible benefit to the cattle, definitely reported for Cattle Egrets, is to warn them of approaching danger. Obviously under conditions of domestication this is of no concern to the cattle, but some of my observations on this point are of interest. Whenever I openly approached groups of cattle, the egrets always took flight when I was still some distance away, but the cattle expressed only mild curiosity on my closer approach. These reactions were no doubt due to the fact that the cattle are domestic, the egrets wild. However, when I attempted to stalk them behind

cover, the cattle invariably noticed me first, sometimes bolting and putting the egrets to flight, whereas I could approach unseen very close to the egrets when the cattle did not alarm them. Thus it seems that under some circumstances it may be the egrets which benefit from the reaction of the cattle.

Speculating on the origin of this symbiotic association, it is interesting to note that the ranges of Snowy Egrets and the larger indigenous grazing animals were mostly mutually exclusive. (The egrets do not associate with smaller ungulates. I never saw them with a herd of goats kept in a pasture adjacent to one where I made many of these observations, nor with sheep on Payne's Prairie.) Snowy Egrets have obviously acquired this habit since the introduction of domestic cattle into Florida. Why Snowy Egrets developed this habit, while none of our other herons did, is an unanswered question. Although seven other species of herons are abundant in this region, and some, especially Greater Egrets (*Casmerodius albus*), regularly feed in pastures, I have never, with one exception, seen any of them associating with cattle. The one exception was an immature Little Blue Heron (*Florida caerulea*) which was with a small group of Snowy Egrets.

Here Snowy Egrets fill an ecological niche which is occupied in the Old World by Cattle Egrets. Since the colonization of Florida by the latter species in 1948, the interactions between the two should be well worth investigating.—DALE W. RICE, *Department of Biology, University of Florida, Gainesville, Florida.*

Habitat of the Screaming Seedeater (*Sporophila caerulescens*) in Brazil.—In 'The Auk' for October 1952 (69: 433) Dr. A. O. Gross writes of the establishment of Hick's Seedeater, or the Variable Seedeater, (*Sporophila aurita aurita*) as a breeding bird on Barro Colorado Island, Panama Canal Zone. He expresses some surprise that the species, a typical bird of open grassy country, should have found and settled in such a relatively small grassy area as exists on the island.

In Brazil, in the region of Rio de Janeiro, and elsewhere, a related form, *Sporophila caerulescens*, occurs very commonly. It too is essentially a bird of open country, being particularly abundant along grassy roadsides. But I also find it in relatively small and isolated areas. One such area occurs on the summit of a low hill in the Parque da Cidade, Rio de Janeiro, where there is a cleared grassy space of perhaps two acres, completely surrounded by heavily wooded hillside. Here I nearly always find the Screaming Seedeater singly or in small flocks of mixed adults and juveniles; and it may very well breed there, though to date I have found no nest.

I also found a seemingly resident male in the almost grassless garden of a house completely surrounded by "mata" near the top of Corcovado Mountain in the city of Rio de Janeiro, at an elevation of about 600 metres. This bird was heard singing all day during my week-end visit to the house and seemed to have his singing-tree established. No female was seen. This was January 24 to 26, 1953.

So it would appear that at least this species of Seedeater and *Sporophila aurita* travel far and over inhospitable country to find and establish their "niches."

This fact is particularly puzzling here in view of the great stretches of deforested and now grassy country which occur in the two states with which I am familiar, Rio de Janeiro and São Paulo, and which would seem to preclude the necessity of the species seeking small isolated areas for breeding.

Incidentally, *Sporophila caerulescens* has a pleasing song which is also reminiscent to me of that of the Indigo Bunting, as was that of the Variable Seedeater to Dr. Gross. And I have never heard it "scream," and trust that some recent publication has given it a more appropriate common name. MARGARET H. MITCHELL, *COBAST, Caixa Postal 4965, Rio de Janeiro, Brazil.*

Immature Females with Adult Male Plumage Characters.—In general, when there is sexual dimorphism in birds, the young bird's first plumage of contour feathers may be similar to that of the parent of its sex or to that of the female parent, or it may be neutral, asexual, and presumably phylogenetically older than the adult plumage. To have the young female show plumage characters of the adult male, only acquiring the adult female plumage later, is a condition present in very few species. Stonor (Ibis, 1937: 178–179) brought together records of four species in which this occurs: two hornbills, one duck, and one woodpecker. Whistler (Ibis, 1937: 408–409) added another, a cuckoo. To this short list it is possible to add several more. The following are all the examples known to me:

ANATIDAE.—The young female of the New Zealand Paradise Duck (*Casarca variegata*) has a black head like that of the adult male, not acquiring the white head of the adult female until the post-juvenile molt (Sclater, quoted by Stonor). Stonor points out that this is correlated with the female's taking the more active part in courtship.

Delacour and Mayr (Wilson Bull., 57: 15, 1945) point out that in the three related species, *Casarca ferruginea*, *C. cana*, and *C. tadornoides*, which have less sexual dimorphism than *C. variegata*, the juvenile plumage of both sexes also resembles that of the adult male and is always different from that of the adult female, though not conspicuously so.

TURNICIDAE and PEDIONOMIDAE.—In the 14 species of button quail and the related Plains Wanderer, it is the rule for the young to resemble the male which is less brilliantly colored than the female. This condition is correlated with the more active role of the female in courtship and with the assumption of the duties of incubation by the male.

BUCEROTIDAE (hornbills).—The young female *Rhyticeros* (=*Aceros*) *plicatus* has a light chestnut-brown head like that of the adult male; it acquires the black head of the adult female during the "first post juvenile moult" (Stonor, *op. cit.*).

In *Ptilolaemus tickelli* the plumage of the young female is like that of the adult male, and unlike that of the adult female (Stonor, Ibis, 1936: 179, editor's footnote).

Three full-grown young hornbills (*Aceros leucocephalus*) collected in Mindanao, Philippines, by Dr. D. S. Rabor and sent to the Chicago Natural History Museum, include a male in a plumage similar to that of the adult; a male undergoing extensive head molt into its second plumage which is similar to both the first plumage and that of the adult male; and a third bird, of about the same age, judging by the small unwrinkled bill, which is a female. The head of the female is in heavy molt. About half of the head is covered with a buffy and chestnut, old, plumage similar to that of the adult male; the incoming feathers, which cover about half the head, are black, like those of the adult female.

CUCULIDAE (cuckoos).—In parts of the Asiatic range of the Koel (*Eudynamys scolopacea*), the young female is black or blackish, approaching the black condition of the adult male rather than the brown of the adult female; however, in the Australian-Papuan part of its range, both nestling male and female are brown, like the adult female. There is thus geographical variation in the immature plumage.

Presumably this is correlated with these cuckoos' parasitizing crows in the Asiatic area and honey eaters in the Australian area. The former have black and the latter brown, young; it is probably an advantage for the young cuckoos to resemble the young of their foster parents.

PICIDAE—In some woodpeckers of the genus *Dendrocopos*, the young male and the young female may have more red on the head than the adult female, and some-

times more than the adult male. The red is on the crown in the young, rather than on the nape as in the adult.

In the three-toed woodpeckers (*Picoides*) the young female has a yellow crown similar to the condition in the adult male.

In the Yellow-shafted Flicker (*Colaptes auratus*), the malar areas of the males are black and those of the adult female are tan. The young of both sexes, however, have black malar stripes.

STURNIDAE.—In a Starling (*Onychognathus blythii*) of Sokotra the young female is said to have the head and neck black as in the male, rather than gray as in the adult female (Ogilvie-Grant and Forbes, 1903, *Natural History of Sokotra . . .* Aves, p. 23, Liverpool).

The presence of adult male characters in the female is in some cases (Paradise Duck) correlated with the more active role of the female in courtship, and in some cases (button quail) with a partial reversal of the roles of the sexes, the male assuming the duties of incubation. In the case of the Koel, a social parasite, the color of the young varies geographically and is correlated with the color of the young of the foster parents. In other cases (the starlings, hornbills, and woodpeckers) there is no obvious correlation.

That such a condition is not widespread throughout a group is shown by the hornbills and the woodpeckers. Some species of hornbills have a juvenile plumage different from that of either adult.

In the woodpeckers, the young may differ from both parents, young males may resemble adult males and young females may resemble adult females, or young of both sexes may resemble the adult male. A. L. RAND, *Chicago Natural History Museum, Chicago, Illinois.*

Further Comments on the Breeding Season of Barn Owls in Southern California.—In referring to my paper, "Dispersal, Breeding Behavior, and Longevity of Banded Barn Owls in North America" (Auk, 69: 227–245, 1952), Wilson C. Hanna (Auk, 71: 90, 1954) stated, "I was astonished to note (page 244) that 'Barn Owls in southern California breed only during March, April, May, and June, with the peak occurring in April'." Hanna presented nesting dates for Barn Owls in Southern California and pointed out that his records for 32 sets of eggs fall in the period between mid-January and mid-April. He stated that the mean date for all sets of eggs was March 10. The stages of incubation are not indicated in each case, but fresh or slightly incubated eggs were reported for January 16 and April 17.

By implying disagreement which does not actually exist between our independent conclusions, Hanna creates confusion regarding the breeding season of Barn Owls in southern California. It is unfortunate that Hanna's quotation from my paper was removed from its context. The sentence following that quoted by Hanna states, "All of the months given represent the time of banding and should be adjusted backward about six or seven weeks, if the dates of egg laying are desired." If the necessary time is allowed for the eggs to hatch and for the birds to reach an age suitable for banding, a strikingly close agreement will be found between the breeding period indicated by the banding records and that indicated by Hanna's oölogical data.—PAUL A. STEWART, *Ohio Cooperative Wildlife Research Unit, Department of Zoology and Entomology, Ohio State University, Columbus 10, Ohio.*

RECENT LITERATURE

The Birds of the Belgian Congo, Part. 4.—James P. Chapin. Bull. Amer. Mus. Nat. Hist., 75B: 1–846, 27 pls., 46 text figs. July, 1954.—The appearance of the fourth volume of Chapin's great work on the birds of the Belgian Congo brings to a conclusion one of the greatest faunal works produced by any living ornithologist, and what is certainly the most important treatise on Old World birds to stem from an American investigator. The present volume deals with the drongos (*Dicruridae*), shrikes (*Laniidae*), helmet-shrikes (*Prionopidae*), tits (*Paridae*), creepers (*Certhiidae*), orioles (*Oriolidae*), crows (*Corvidae*), starlings (*Sturnidae*), white-eyes (*Zosteropidae*), sunbirds (*Nectariniidae*), weaverbirds (*Ploceidae*), and finches (*Fringillidae*). At the end of these accounts is a chapter devoted to additional species recorded from, or deemed of probable occurrence in, the Belgian Congo, not listed previously, as well as new data on a few birds already treated in earlier volumes. Notable among these last are the Lyre-tailed Honey-guide (*Melichneutes robustus*), a bird that Chapin has long been urging residents in tropical Africa to watch for and observe, and the Congo Peacock (*Afropavo congensis*), a bird that will always be associated with Chapin's name.

As in the previous volumes of this work, many of the species accounts contain hitherto unpublished facts on the habits of the birds, and in some cases these data constitute most of what is known of them. No one studying either the habits or the systematics of African birds can afford to overlook this work.

A feature that will prove of great usefulness to a circle wider than the ornithological one alone is the hundred pages devoted to a gazeteer of all African localities mentioned in all four volumes. Inasmuch as many of the older localities were names of native villages no longer in existence and all but impossible to trace at this late date, the information here brought together at the expense of much painstaking searching over many years will be invaluable to workers in all fields that involve African sites. It is understood that this section may be issued separately from the rest of the volume and become available to investigators whose interests lie elsewhere than in ornithology. An extensive bibliography (70 pages) covers all the literature for all four of Chapin's volumes. This, too, will be a most useful index to African ornithological literature far beyond the geographic limits of the great Belgian colony.

In almost a peculiar sense this work represents the activity of a working lifetime. Since 1909 when the author went out to the Congo, until the present (when he is again there), the ornithology of that area has been Chapin's preoccupation. It is true that he has done other things and made trips elsewhere, but the birdlife of central Africa has been his main continuing and ever present study. The four stout volumes that he has produced are therefore, more than merely the results of a long and devoted period of conscientious effort; they are the results, as well, of a way of living. The many problems, big and little, that arose and had to be solved have brought the author into closer contact with the museums of Europe and with a host of travellers, local government officials, planters, missionaries, and schoolteachers than has fallen to the lot of most of us. His personal correspondence has been enormous, and most of it was devoted to stimulating observers on the scene, to encouraging others, and to guiding and assisting investigators in the African field. While, to the reader of these volumes much of the material presented may be largely matter-of-fact, to the author it must be evocative enough, of beautiful places it caused him to visit, of interesting personalities it brought him to know, and of events and discoveries of which he thereby became a participant.

As a record of a life of scholarship well spent, Chapin's four volumes should become a symbol, as well as a most useful and important literary tool to his colleagues. The American Museum of Natural History may take a well merited pride in having given the author the opportunity and the necessary support to achieve the splendid results which the present volume brings to completion.—HERBERT FRIEDMANN.

Avian Physiology.—PAUL D. STURKIE. Ithaca: Comstock Publishing Associates. xx + 423 pp., 77 figs. in text. 1954. Price: $6.00. A need has long existed for a comprehensive synthesis of information on the physiology of birds. Books on comparative physiology (e. g., Prosser *et al.* "Comparative animal physiology." Phila.: Saunders, 1950) were not designed to meet this need, and until now there has been no book solely devoted to the physiology of birds. In view of this situation, Professor Sturkie's work constitutes an important step toward the achievement of such a synthesis.

The title of this book is somewhat misleading, for only work on "the chicken," "the pigeon," and "the duck" is considered in detail. Professor Sturkie indicates in the preface that the book is so restricted "because most of the research has been conducted on these species and they represent species of economic importance to man." This is true. However, since the book is presented as an account of avian physiology, I do not believe it justifies the wholesale omission of information on the physiology of wild birds.

The text comprises 21 chapters, which deal with the general topics of circulation, respiration, temperature regulation, energy metabolism, digestion, sense organs, reproduction, and the endocrine system. A list of references cited is presented at the end of each chapter. This is "extensive but not exhaustive. An attempt was made to select the most important and most recent references, with minor consideration being given to priority." The complete title of each reference is given, a practice often neglected in physiological publications.

The 77 text figures include a large number of graphs reproduced from the articles in which they appeared originally. Drawings and photographs showing apparati or details of anatomy and histology are also numerous. The quality of these illustrations is generally good. Evaluation of statements made in the text is facilitated by many tables. There are several typographical errors in this book, but no more than might be expected in the first printing of a work its size.

The chapters dealing with circulation constitute almost a quarter of the text. Professor Sturkie seems partial to this subject; certainly he has carried out a good deal of research on it. Considerable detail is devoted not only to the results of various investigators, but also to techniques used by them. A chapter on electrocardiography is included.

The avian respiratory system is treated extensively. Information is presented on anatomy as well as on physiology. A table (17) which summarizes data on respiratory rates of several species is limited in usefulness by the omission of the air temperatures at which the determinations were made. The author fails to utilize the important work of Zeuthen (Det Kgl. Danske Videnskabernes Selskab, Biologiske Meddelelser, 17: 1–51, 1942) in his discussion of the air sacs. The very brief account he does give of this work (taken from Krogh, "The comparative physiology of respiratory mechanisms." Phila.: U. Penna. Press, 1941) is marred by his persistent misspelling of Zeuthen's name. Following the chapter on respiration is a summary of information on the transport of blood gases, which includes a comparison of the oxygen dissociation curves of birds and mammals.

The chapter on body temperature pertains almost entirely to work on the chicken.

Only brief mention is made of the work of Baldwin and Kendeigh (Sci. Publ. Cleveland Mus. Nat. Hist., 3: 1–196, 1932). The omission of data on the diurnal temperature cycles, critical temperatures, and lethal body temperatures of wild birds is regrettable, since considerable information does exist on them. The latter part of this chapter deals with hypothermia, effects of high air temperatures on chickens, and mechanisms associated with the regulation of body temperature. A graph showing the effect of air temperature on evaporative water loss in some species would have been a useful addition to this section. Naturally occurring torpidity in certain birds is not discussed, even though information has been available on it for several years.

In the chapter on energy metabolism, the author points out that basal metabolic rate varies with the 0.73 power of body weight in birds and mammals as a group, and in Rhode Island Red Chickens. He fails to point out that basal metabolism varies with the 0.64 power of weight when birds alone are considered and that the relationship for the chickens pertains only when both the normal and bantam varieties are included. Within the normal variety of Rhode Island Red Chicken, basal metabolic rate varies with the 0.54 power or less of body weight (Brody, "Bioenergetics and growth." N. Y.: Reinhold Publ. Corp., 1945).

The discussion of the effects of temperature on energy metabolism deals only with the chicken. Professor Sturkie does not mention the important work of Scholander *et al.* (Biol. Bull., 99: 237–258, 1950) on heat regulation of arctic and tropical birds and mammals, nor does he utilize any of the French and German literature on avian metabolism. The usefulness of this chapter is further limited by the failure to consider the metabolic responses to temperature of young altricial birds.

The discussion of digestion is informative. It includes anatomical as well as physiological information. The chapter on carbohydrate metabolism seems to summarize effectively what is known of this topic in birds. Of particular interest is the section on endocrine control of carbohydrate metabolism.

A most useful discussion is presented of the anatomy and physiology of the avian kidney and associated structures. This includes information on filtration pressures and on the clearances of various substances, including uric acid. Available information on excretory products is summarized, and the evidence that the cloaca does not function importantly in water conservation is presented.

The chapter on sense organs includes discussions of vision, hearing, taste, and smell. No mention is made of how the eyes of certain aquatic birds accommodate under water. Interesting data on the range of frequencies which various birds can hear is presented, and the old controversy as to whether or not vultures find their food by smell is briefly considered.

The excellent account of reproduction in the female includes information on anatomy and histology, as well as on physiology. Ovulation and the formation of the various components of the avian egg are considered in a comprehensive manner, and there is a summary of those aspects of calcium metabolism which are associated with formation of the shell. The bibliography for this chapter is extensive. Consideration of reproduction in the male is briefer but equally useful.

The last four chapters of this book deal specifically with the endocrine system. They constitute a useful guide to the extensive literature on the endocrinology of chickens, pigeons, and ducks. The discussions of the various components of this system are in some cases prefaced with an account of anatomy and histology. The chapters deal respectively with the hypophysis; gonadal hormones; thyroids; and the parathyroids, thymus, and pancreas. No endocrine function has been demonstrated for the thymus.

These four chapters are generally good. It is regrettable that the discussion of photoperiodism is virtually confined to the duck. (This is also true for the one presented in the chapter on reproduction in the male.) The work of the past three decades on this phenomenon certainly merits more attention than it is given in this book. Another deficiency of this section is the failure to consider the hormonal control of the incubation patch. A discussion of the effects of hormones on such activities as aggressive behavior and broodiness would have been of value to ornithologists.

For some reason, the author does not consider the physiology of skeletal muscle in this book. Furthermore, he does not discuss the occurrence of pre-migratory fat deposition in certain species of birds.

In spite of the inadequate treatment of work on the physiology of wild birds, Professor Sturkie has accomplished a majority of the goals which he set for himself. This book will undoubtedly be useful in courses on poultry science and veterinary medicine. Furthermore, it will probably stimulate interest in the former discipline. Perhaps its most important function for ornithologists will be as a guide to an important part of the vast literature on poultry, which at present is all too infrequently used by them.—WILLIAM R. DAWSON.

A Species Index to *The Emu*. Volumes 1 to 50, 1901–1951.—COMPILED BY ARNOLD R. MCGILL. Melbourne: Royal Australasian Ornithologists Union. vi + 183 pp. 1953. Price: one pound, one shilling, plus postage (9d. to British Empire countries, 1/5 foreign).—This useful work consists of two sections, a species index and a contributors' section. It is prefaced by an account of the methods followed in preparing it. The compiler wisely listed all references to a given species in one place, under the scientific name currently used in 'The Emu.' The names are arranged alphabetically by genera, and alphabetically by species and subspecies within the genera. Specific and subspecific names are also indexed separately with cross references to the genera under which the references are listed. Synonyms which have appeared in 'The Emu' are also indexed with a cross reference to the currently accepted name. Vernaculars are given with each accepted scientific name, but are nowhere listed alphabetically.

This work will be indispensible to students of Australian birds, and a copy should be in every library which has a file of 'The Emu.' Mr. McGill and the Royal Australsian Ornithologists Union are to be congratulated and thanked for bringing out this valuable index.—ROBERT W. STORER.

The Biology of Birds.—HARRY W. HANN. Ann Arbor. Edwards Brothers, Inc. 153 pp., 10 pls. 1953. $2.50.—This book summarizes the phases of ornithology which can best be taught to college students beginning the study of ornithology. It is offset printed with illustrations which are of good quality. Most of the illustrations are line drawings, five of which are original; there are two plates of photographs by the author. The bibliography provides a good introduction to the literature of ornithology. There is an adequate index. The use of underlining emphasizes important points and headings.

The outstanding features of the anatomy and physiology of the organ systems are presented clearly and with few omissions, although sometimes with almost outline-like brevity. Bird flight, migration, the breeding cycle, anting, longevity, bird banding, distribution, conservation, wildlife refuges, economic importance, and attracting birds all are discussed. Thus the content of the book is greater in scope than the title indicates.—JOSEPH C. HOWELL.

The Lives of Wild Birds.—ARETAS A. SAUNDERS. Garden City, N. Y. Doubleday and Co., Inc. 256 pp., 21 pls. (pen sketches). 1954. $3.50.—It is apparent that Mr. Saunders has spent a great deal of time out-of-doors in the careful study of birds. In this book he approaches all subjects from the viewpoint of the field ornithologist with the objectives of interesting the layman in birds and of providing him with the fundamental facts and concepts necessary for an intelligent pursuit of bird study. In dealing with numerous subjects the author uses his own field studies to provide fresh examples. The need for additional field observations is brought to the attention of the reader at appropriate points in the text.

An early chapter on the identification of birds in the field discusses how to use the characteristics of color, marking, size, shape, habit, posture, songs, and calls. The role of birds' habitats in identification also is commented on briefly. The importance of keeping notes and how best to record them are emphasized. In a section devoted to watching migration, attention is directed to the types of areas which best permit observation and to the best seasons, hours of the day and night, and weather conditions. Included in the chapter dealing with nesting activities are accounts of the territory theory, courtship, nest building, egg laying, incubation, care of young, and second nestings. Bird behavior is considered principally as it relates to feeding habits and predators. Plumages and their relations to molts, feather wear, age, season, and the environment are discussed. In addition to pointing out the biological significance of bird songs and calls, the author briefly describes their variety, relation to weather, time of day, and season, and a graphic method of recordding them. The food and feeding habits of birds are outlined. The dependence of birds upon particular environments is noted, and further the relationship between the extent of the environment and the size of the bird population. As regards conservation, the author believes that the emphasis should be shifted away from the economic importance of birds to their esthetic value to an ever-increasing group of people who enjoy observing living things in their natural environment.—JOSEPH C. HOWELL.

An Album of Southern Birds.—PHOTOGRAPHS BY SAMUEL A. GRIMES, TEXT BY ALEXANDER SPRUNT, JR. Austin: University of Texas Press. 103 pp., 103 pls. (4 in color). Price: $8.75.—S. A. Grimes' handsome photographs have been appearing in books and magazines for years, and it is a pleasure to have a book devoted to his work. The pictures are generally excellent, and many photographs of rare or shy species such as the Black Rail, the Black-whiskered Vireo, Swainson's Warbler, and the Seaside Sparrow are included. On the other hand, the pictures of several birds (e.g. the Black Vulture, the Barred Owl, and the Snowy Egret), although excellent, have been published so many times before that it is difficult to justify republishing them again. Certainly Mr. Grimes must have many more unpublished photographs which could have been substituted for them and which would have contributed more to our knowledge and appreciation of birds.

Mr. Grimes is an engraver by profession, and his company made the cuts for the black and white illustrations. The excellence of this work should prove a fine advertisement for the company. However, the colored plates, which were made by another firm, are rather poor; the Canada Warbler, for instance, is shown with a bright blue back, an error which has probably caused the photographer no little embarrassment.

Of particular interest to other photographers will be the data for each picture—make of camera, kind of lens, exposure, and kind of film. This information is to be found in the table of contents where presumably it will not offend the esthetic eye.

Sprunt's text includes an appreciation of Grimes and legends for the photographs. Its style can best be shown by two samples. "What was that slipping through the grass—a mouse, or a swiftly moving shadow? No, a bird, tiny, silent and mysterious, known only to those who seek diligently in marsh and oatfield." (Black Rail, page 44.) "Remnant of the Age of Reptiles, the Snakebird is almost a modern icthyornis [*sic*]. A strange, silent dweller in cypress gloom and willow swamp—remote, fantastic, unearthly." (Water Turkey, page 26.)

Approximately eighty per cent of the photographs show adult birds either at the nest or with young, an example of the trend which bird photography has followed since its beginnings. This is undoubtedly because birds are most easily photographed at the nest and because young birds have great popular appeal. However, the potentialities of bird photography as a scientific tool are only now being realized. As our knowledge of bird behavior increases, the need for good illustrations of displays and postures becomes more evident. Furthermore, photographs of birds walking, swimming, or flying constitute a valuable tool in the interpretation of anatomical studies. The esthetic and utilitarian aspects of bird photography need not be divorced; pictures of birds displaying or in flight can be even more pleasing to the eye than those of birds at the nest.—ROBERT W. STORER.

Biographies of Members of the American Ornithologists' Union.—T. S. PALMER AND OTHERS. Reprinted from 'The Auk,' 1884–1954. Baltimore: Lord Baltimore Press. 630 pp.—Dr. Palmer, former secretary and long-time member of the Committee on Biography of the A.O.U., has collected all the short biographies of members (and of 66 non-members) which were published in 'The Auk' from 1884 into 1954. Approximately 70 hitherto unpublished biographies are also included, bringing the total to about 1,200. Deceased fellows for whom memorials have been published are not listed nor is reference made to where to find these memorials. Despite this gap, the book will prove of considerable value as a reference work.

Dr. Palmer has kindly donated a supply of copies of his book to the Union. They have been priced at $5.00 and may be purchased from the treasurer.—ROBERT W. STORER.

ABBOTT, W. G. 1954. Leaf bathing of the Mockingbird. Condor, **56**: 163–164.

ALDRICH, J. W., *et al.* 1954. Investigations of Woodcock, Snipe, and Rails in 1953. U. S. Dept. Interior, Fish and Wildlife Service Special Scientific Report—Wildlife No. 24, ii + 68 pp. (mimeographed).—Twelve short papers, mostly on censuses of Woodcock and Wilson's Snipe, with a summary by Aldrich.

AMADON, D. 1953. Remarks on the Asiatic Hawk-eagles of the genus *Spizaëtus*. Ibis, **95**: 492–500.—*S. nanus stresemanni*, Nias Is., new subspecies.

AMADON, D. 1954. A bird new to Palawan. Philippine Journ. Sci., **81** (2): 139.—*Milvus migrans lineatus* taken in winter.

ARMSTRONG, E. A. 1954. The behaviour of birds in continuous daylight. Ibis, **96**: 1–30.—A survey of observations relating to factors that influence daily activity of birds at high latitudes. The length of the quiescent period is examined for some members of the Falconiformes, Charadriiformes, Strigiformes, and Passeriformes; light is postulated as the dominant extrinsic factor. The length of the nestling period seems to be shorter at higher latitudes for some passerines. The adaptive value of coloration of some birds is related to the degree of their activity in dim light.

AXELL, H. E. 1954. The Wheatear at Dungeness. Bird Notes, **26**: 38–41.

BARTHOLOMEW, G. A., JR., and W. R. DAWSON. 1954. Body temperature and water requirements in the Mourning Dove, *Zenaidura macroura marginella*. Ecol. Monogr., **35**: 181–187.—Nighttime temperature averaged 2° C. lower than daytime temperature of 41.5° C. When kept at 39° C. air temperature, body temperature rose, more markedly when the birds were deprived of water. Birds drank four times as much water at 39° C. than at 23° C. air temperatures. Twenty-four hours at 39° C. without water resulted in a loss of 15 per cent of body weight, but normal weight was recovered within a few minutes when the bird was again given water. The species is well adapted to desert conditions.

BEEBE, W. 1954. Discovered—the nest and egg of the Black-winged Bellbird. Animal Kingdom, **57**: 115–119.—*Procnias averano carnobarba* in Trinidad.

BEECHER, W. J. 1954. On Coriolis force and bird navigation. Scientific Monthly, **79** (1): 27–31.—A reconsideration of the theory that birds may be able to use the Coriolis effect in night migration. An earlier statement of this theory (1951 and 1952) is changed in at least one particular.

BERGER, A. J. 1954. Association and seasonal succession in the use of nest sites. Condor, **56**: 164–165.—*Empidonax traillii*, *Dendroica petechia*, and *Spinus tristis* built nests in the same type of vegetation but generally nested at different times during a given season. The seasonal succession would seem to provide a means whereby competition for nest sites is reduced.—D. W. Johnston.

BERGER, A. J. 1954. The myology of the pectoral appendage of three genera of American cuckoos. Misc. Publ. Mus. Zool., Univ. Mich., **85**: 35 pp., 4 figs.—A comparison of the pectoral muscles of *Coccyzus erythropthalmus*, *C. americanus*, *Crotophaga sulcirostris*, and *Geococcyx californianus*. "Differences in flight pattern in the three genera may best be explained in terms of a progressive reduction in relative wing area and a progressive increase in body size from *Coccyzus* to *Geococcyx*." The musculature of *Crotophaga* is illustrated.

BERGER, A. J. 1954. Injury-feigning by the Catbird [*Dumetella carolinensis*]. Wilson Bull., **66**: 61.

BLANCOU, J. 1953. Première capture de *Calandrella cinerea* en Afrique française. L'Oiseau, **23**: 304–305.—First record for French West Africa.

BLASZYK, P., and G. STEINBACHER. 1954. Zur Vogelfauna der ukrainischen Krautsteppe. Bonner Zool. Beitr., **5**: 49–67.

BLAU, M., E. S. DEEVEY, JR., and M. S. GROSS. 1953. Yale natural radiocarbon measurements, I. Pyramid Valley, New Zealand and its problems. Science, **118** (3053): 1–6.—Age of Moa crop contents given as 670 years.

BLYTH, J. S. S., and R. W. HALE. 1953. Unilateral defective feathering in a purebred pullet. Journ. Heredity, **44** (5): 181–183.

BORRERO H., J. I. 1953. Notas preliminares sobre habitos alimenticios de palomas silvestres Colombianas. Caldasia **4**: 75–80.—Food of *Zenaida auriculata*, *Columba fasciata*, and *C. cayennensis* in Colombia.

BORROR, D. J., and C. R. REESE. 1953. The analysis of bird songs by means of a vibralyzer. Wilson Bull., **65**: 271–276, 7 figs., 1 table.—The loudness, rhythm, and frequencies of bird songs can be determined by an electronic frequency analyzer recording frequency and intensity on a time scale. The instrument is described and some general conclusions made about several bird songs.

BOURLIÈRE, F. 1953. Sur le comportement de *Gracupica nigricollis*. L'Oiseau, **23**: 261–264, figs. 1–2.

BRENEMAN, W. R. 1954. The growth of thyroids and adrenals in the chick. Endocrin., **55**: 54–64, 3 figs., 3 tables.

BRODY, G. 1953. Use of the thymus gland in chicks to elucidate interrelationships between pteroylglutamic acid and biologically related substances. **Science, 118** (3076): 720–721.

BURGER, G. V. 1954. The status of introduced wild turkeys in California. **Calif. Fish and Game, 40:** 123–145.

BUXTON, E. J. M. 1953. Migration of birds observed in N. W. Germany 1942. **Ibis, 95:** 235–241.

CAIN, A. J. 1954. Affinities of the fruit-pigeon *Ptilinopus perousii* Peale. **Ibis, 96:** 104–110.

CARRICK, R., and G. M. DUNNET. 1954. Breeding of the Fulmar *Fulmarus glacialis*. Ibis, **96:** 356–370.—296 banded Fulmars were studied on Eynhallow, Orkney Islands. Both sexes can breed in successive years. Adults apparently do not change either their mate or their nest site over the years. The timing of the breeding season varies from year to year, suggesting that the Fulmars are not independent of environmental variation, as has occasionally been maintained.

ČERNÝ, W. 1953. O hnízdění zrzohlavky (*Netta rufina* PALLAS) v Čechách. Sylvia, **14:** 28–35.—The breeding of the Red-crested Pochard in Bohemia. In Czech with German summary.

ČERNÝ, W. 1953. Hnízdění kulíka písečného (*Charadrius hiaticula*) na Inářských rybnících. Sylvia, **14:** 74–81.—The arrival of the Ringed Plover as a breeding bird in Bohemia. In Czech with a German summary.

CHITTY, D. 1954. Tuberculosis among wild voles: with a discussion of other pathological conditions among certain mammals and birds. Ecol. Monogr., **35:** 227–237.—Mammals and game birds are less resistant to infectious diseases at some population densities than others owing to changes in physiological condition.

CLANCEY, P. A. 1954. Comments on geographical variation in the Tit-babbler *Parisoma subcaeruleum* (Vieillot) and the description of a new race from the high interior of Natal, South Africa. Bull. Brit. Ornith. Club, **74** (3): 30–33.—*Parisoma subcaeruleum orpheanum*, new subspecies.

CONDON, H. T., and D. AMADON. 1954. Taxonomic notes on Australian Hawks. Rec. S. Australian Mus., **11** (2): 189–246.—The following genera are discussed: *Elanus, Aviceda, Milvus, Lophoictinia, Hamirostra, Haliastur, Accipiter, Erythrotriorchis, Hieraaetus, Aquila, Haliaeetus, Circus*, and *Falco*. *Aviceda subcristata njikena* (Fitzroy River, West Australia), *Haliastur indus flavirostris* (Bougainville Is., Solomons), and *Aquila audax fleayi* (Great Lakes, Tasmania), new subspecies.

CONNER, M. H., and C. S. SHAFFNER. 1953. An arched-neck character in chickens. Journ. Heredity, **44** (6): 223–224.

CONNER, M. H., and C. S. SHAFFNER. 1954. Effect of altered thyroidal and gonadal activity on size of endocrine glands and resistance to stress in the chick. Endocrin., **55:** 45–53. 1 fig., 3 tables.

COTT, H. B. 1953–1954. The exploitation of wild birds for their eggs. **Ibis, 95:** 409–449, 673–675; **96:** 129–149.—An important record, complete to July, 1951, of the history of the exploitation, primarily for food, of various bird populations by men and the probable best methods for conservation of this resource at the present and in the future. It is difficult to believe that a more complete account could have been compiled.

CULLEN, J. M. 1954. The diurnal rhythm of birds in the Arctic summer. **Ibis, 96:** 31–46.—*Fulmarus glacialis, Rissa tridactyla*, and *Uria lomvia* were studied with regard to flight, sleeping, and preening rhythms.

DATER, E. E. 1953. Casting of a Pileated Woodpecker. Wilson Bull., **65**: 280.—Of *Dryocopus pileatus*, containing many fragments of carpenter ants.

DAVIS, J. 1954. Seasonal changes in bill length of certain passerine birds. Condor, **56**: 142–149.—This important study demonstrates an increase in bill length of certain passerine species during the summer months at which time there is less wear on the bill. In the winter when these species are largely vegetarian there is more wear on the bill tips so that the length of the bill is significantly shorter than for the same species during the summer. These findings should caution the taxonomist when analysing the bill lengths of species in which the diet varies seasonally. D. W. Johnston.

DAVIS, T. A. W. 1953. An outline of the ecology and breeding seasons of birds in the lowland forest region of British Guiana. Ibis, **95**: 450–467.—The topography, climate, and natural vegetation are described. The principal bird breeding season comes at the close of the short dry season. There occurs also a second, general, but very weak, peak of nesting in September.

DAVIS, T. A. W. 1954. Notes on northern migrants observed inland in British Guiana. Ibis, **96**: 441–448.—Observations on 22 species, 19 of which are known migrants from North America.

DEEVEY, E. S., JR. 1954. The end of the Moas. Scientific American, **190** (2): 84–90.

DIXON, K. L. 1954. Some ecological relations of chickadees and titmice in central California. Condor, **56**: 113–124.—This excellent report summarizes many interspecific relations between "invading" *Parus rufescens* and already-present *P. inornatus*. The two species differ not only in foraging habits but also in size of food items, thus strengthening Lack's contention concerning food habits of sympatric closely-related species. Even though the preferred habitats are not always entirely different, *rufescens* and *inornatus* have mutually exclusive breeding territories. The "invading" *rufescens* has had to adjust to coöccupancy with *inornatus* by using vacated or suboptimal nesting territories.—D. W. Johnston.

DUGAN, W. D. 1953. Unintentional live-trap for American Mergansers. Wilson Bull., **65**: 279.—Females of *Mergus merganser* enter chimneys and are trapped.

ELDER, W. H. 1954. The oil gland of birds. Wilson Bull., **66**: 6–31, 4 figs., 1 table.—This documented review of the literature on the uropygial gland and report on some recent experiments concludes that the secretion of the gland is necessary for plumage maintenance, at least in waterfowl, and that it may help in supplying vitamin D.—J. T. Tanner.

ELLIOTT, H. F. I. 1954. On two new races and an undescribed variety from the Tristan da Cunha Group. Bull. Brit. Ornith. Club, **74** (2): 21–24.—*Nesocichla eremita procax*, Nightingale Island; *Pelecanoides urinatrix elizabethae*, Gough Island, new subspecies.

FARNER, D. S., J. R. MEWALDT, and S. D. IRVING. 1953. The roles of darkness and light in the activation of avian gonads. Science, **118** (3065): 351–352, 2 tables.—It has been shown that a given photoperiod produces a greater gonad-stimulating effect if given with one or more interruptions than if given without an interruption. The writers suggest that the effects of the light begin to operate shortly after the initial exposure and that there is a carry-over period after the close of the period of light. The interruption of the photoperiod then provided one or more additional carry-over periods.

FARSKÝ, O. 1953. Ještěrky v potravě krahujce. Sylvia, **14**: 91–93.—Lizards (*Lacerta*) eaten by *Accipiter nisus*. In Czech with a German summary.

FERIANC, O. 1953. Rozšírenie d'atla sýrskeho severozápadného *Dendrocopos syriacus balcanicus* GENGL. ET STRES. na Slovensku. Sylvia, **14**: 17–22.—The distribution of the Syrian Woodpecker in Slovakia. In Czech with German summary.

FRIEDMANN, H. 1954. A revision of the classification of the honey-guides, *Indicatoridae*. Ann. Mus. Congo Tervuren, in-4°, Zool., **1** (*Miscellanea Zool.*, H. Schouteden): 21–27.—Four genera, 11 species, and a total of 32 forms recognized.

FRINGS, H., and J. JUMBER. 1954. Use of a specific sound to repel starlings from objectionable roosts. Science, **119** (3088): 318–319.—Recordings of distress calls were broadcast from sound trucks into roosts. Starlings were repelled within a few days and did not return prior to their fall migration.

GANIER, A. F., and F. W. BUCHANAN. 1953. Nesting of the White-throated Sparrow in West Virginia. Wilson Bull., **65**: 277–279, 1 fig.—Discovery of 2 nests of *Zonotrichia albicollis*, the first known in W. Va.

GOIN, C. J., and O. B. GOIN 1954. Nest-building behavior of the Carolina Wren [*Thryothorus ludovicianus*]. Wilson Bull., **66**: 59.

GOODWIN, D. 1953. Interspecific differences in the anting movements of some corvine birds. Ibis, **95**: 147–149.—Observations made at the London Zoo.

GOODWIN, D. 1953. Observations on voice and behavior of the Red-legged Partridge *Alectoris rufa*. Ibis, **95**: 581–614.—Observations made on both captive and wild birds in England. Call-notes, display, several aspects of breeding behavior, actions of newly-hatched chicks, dusting, preening, and escape behavior are among the subjects discussed.

GOVIER, W. M., and A. J. GIBBONS. 1954. Pentobarbital inhibition of sulfanilamide acetylation in pigeon liver extracts. Science, **119** (3084): 185–186.

GRABER, R. R. 1954. The Lineated Woodpecker. Wilson Bull., **66**: 5, 1 plate by George M. Sutton.—A brief description of *Dryocopus lineatus* of Mexico and El Salvador.

GRABER, R. R., and J. W. GRABER. 1954. Yellow-headed Vulture in Tamaulipas, México. Condor, **56**: 165–166.—A male of *Cathartes burrovianus* was taken on July 21, 1953, at Tampico. The species has not been recorded previously from Tamaulipas.

GRANT, C. H. B., and C. W. MACKWORTH-PRAED. 1952. On the species and races of the Yellow Wagtails from Western Europe to Western North America. Bull. Brit. Mus. (Nat. Hist.), **1**: 255–268, pls. 33–35.—Seven species recognized.

GRANT, C. H. B., and C. W. MACKWORTH-PRAED. 1954. On *Caprimulgus pectoralis*, *C. fervidus*, *C. fraenatus*, and *C. rufigena quansae*. Bull. Brit. Ornith. Club, **74** (3): 33–34.—*C. fervidus* is believed to be conspecific with *C. pectoralis* and *C. fraenatus* to be a separate species; the validity of *C. rufigena quansae* is confirmed.

GREENE, E. R. 1954. Scott Oriole wintering at Palm Springs. Condor, **56**: 163.—A sight record of *Icterus parisorum* on December 30, 1953.

GRIFFIN, D. R. 1954. Bird sonar. Scientific American, **190** (3): 78–83.—Reports the Oil Bird (*Steatornis caripensis*) uses click of one or two thousandths of a second to locate objects unseen in the darkness about it. Its echo-locating system is like that of bats.

HACHISUKA, M., and T. UDAGAWA. 1953. Contribution to the ornithology of the Ryukyu Islands. Quart. Journ. Taiwan Mus., **6**: 141–279.—Annotated list of 286 species and subspecies. A biographical sketch of Hachisuka by N. Kuroda is appended.

HAGEN, Y. 1952. Birds of Tristan da Cunha. Results of the Norwegian Scientific Expedition to Tristan da Cunha, 1937–1938, No. **20**: 248 pp., 4 pls.—A thorough and interesting account of the birds of one of the most isolated island groups in the world. Includes information on habits, food, breeding cycle, development of the young, and descriptions of molts and plumages of the birds, as well as measurements and other data of taxonomic importance. Illustrated with photographs of many of the birds in life, including the endemic rail (*Atlantisia*), thrush (*Nesocichla*), and bunting (*Nesospiza*). *Catharacta skua hamiltoni* and and *Nesospiza wilkinsi dunnei*, new subspecies.

HALE, J. B. 1954. Robins [*Turdus migratorius*] eating minnows. Wilson Bull., **66**: 70.

HANSON, H. C. 1953. Muskeg as Sharp-tailed Grouse habitat. Wilson Bull., **65**: 235–241, 4 figs.—The habitat of *Pedioecetes phasianellus* in muskeg areas around Hudson and James bays is described, with the use of sedge tussocks for the male display.

HANZÁK, J. 1953. Hnízdění a systematické postaveni čečetek, *Carduelis flammea* L. v. Československu. Sylvia, **14**: 5–16.—The breeding and systematic position of the Redpoll in Czechoslovakia. *C. f. cabaret* is the form present. In Czech with German summary.

HARTLEY, P. H. T. 1954. Back garden ornithology. Bird Study, **1**: 18–27.—A stimulating article on the possibilities for serious study in one's own garden. The specific suggestions on experimental tec iniques should prove especially valuable.

HAVERSCHMIDT, F. 1954. The nesting of the Ridgway Tyrannulet in Surinam. Condor, **56**: 139–141.—For *Camptostoma obsoletum* several nests and their contents are described. Some life history notes on nest building, incubation and fledging are also given.

HAVERSCHMIDT, F. 1953. Notes on the life history of the Black-crested Ant Shrike in Surinam. Wilson Bull., **65**: 242–251, 1 fig., 3 tables.—Describing the song, display, breeding season, and nesting habits of *Sakesphorus canadensis*.

HAVERSCHMIDT, F. 1954. Notes on the nesting of the Cayenne Swift [*Panyptila cayennensis*]. Wilson Bull., **66**: 67–69. 2 figs.

HELMUTH, W. T., III. 1954. The hurricane of 1938,—in retrospect. Birds Long Island, No. **8**: 225–241.—A summary of the destruction of birds during this storm. A biographical sketch of Helmuth by J. T. Nichols is appended.

HOFSLUND, P. B. 1954. Incubation period of the Mourning Warbler. Wilson Bull., **66**: 71.—12 days for *Oporornis philadephia*.

HUDSON, G. E., and C. F. YOCOM. 1954. A distributional list of the birds of southeastern Washington. Research Studies State College, Wash., **22** (1): 1–56, 8 pls.

HUE, F. 1953. Notes sur le Coucou-geai, *Clamator glandarius* dans le midi de la France. L'Oiseau, **23**: 297–299, 1 fig.

HUNTINGTON, C. E. 1952. Hybridization in the Purple Grackle, *Quiscalus quiscula*. Systematic Zool., **1**: 149–170.—A study based on a large series of skins, many banding data, and studies of breeding colonies. Factors in the evolutionary history of the species are discussed.

JEFFREY, F. P., T. W. FOX, and J. R. SMYTH, JR. 1953. Observations on double-yolked eggs from the domestic fowl. Journ. Heredity, **44** (5): 213–216.—Reports on hatching of two chicks, male and female, from a double-yolked egg.

JEWETT, S. G. 1954. The White-winged Crossbill in the Cascade Mountains of Oregon. Condor, **56**: 165.—Three specimens of *Loxia leucoptera* were collected on September 19, 1953.

JIRSÍK, J. 1953. Husa polní islandská, sokol stěhovavý tundrový, káně lesní rezavá a linduška rudokrká v Čechách. Sylvia, **14**: 23–27.—*Anser fabalis brachyrhynchus, Falco peregrinus leucogenys, Buteo buteo vulpinus*, and *Anthus cervinus* in Bohemia. In Czech with German summary.

JOLLIE, M. 1953. Are the Falconiformes a monophyletic group? Ibis, **95**: 369–371.—The author believes the order is composed of "four undoubtedly unrelated groups," Cathartidae, *Sagittarius*, Accipitridae-Pandionidae, and Falconidae.

JOUANIN, C. 1953. A propos de la nidification du Pétrel minute, *Halocyptena microsoma* Coues. L'Oiseau, **23**: 300–302.

JOUANIN, C., and J. PREVOST. 1953. Captures de manchots inattendus en Terre Adélie et considérations systématiques sur *Eudyptes chrysolophus schlegeli* Finsch. L'Oiseau, **23**: 279–287, 1 fig.

KENDEIGH, S. C. 1954. History and evaluation of various concepts of plant and animal communities in North America. Ecol. Mongr., **35**: 152–171.—Presents maps showing the subdivisions of North America proposed by Schoun 1823, Agassiz 1854, Leconte 1859, Cooper 1859, Drude 1887, Merriam 1890, Allen 1892, and in the new concept of biociations. There is an evaluation of modern concepts of communities based on floristics, vegetation, life-zones, biotic provinces, faunal groups, plant associations, and formations and biomes.

KILHAM, L. 1954. Courtship behavior of the Pied-billed Grebe [*Podilymbus podiceps*]. Wilson Bull., **66**: 65.

KING, J. R. 1954. Victims of the Brown-headed Cowbird in Whitman County, Washington. Condor, **56**: 150–154.—349 nests of 44 passerine species were examined in a 200-square-mile area in 1952 and 1953. 4.9 per cent of these nests contained cowbird eggs. Ten species were parasitized, of which the Lazuli Bunting and Song Sparrow were the most common hosts.—D. W. Johnston.

LABITTE, A. 1953. Quelques notes sur la biologie et la reproduction de la Pie bavarde, *Pica p. galliae*. L'Oiseau, **23**: 247–260, fig. 1.—Observations on nesting, size of clutch and incubation.

LACK, D. 1954. Two Robin populations. Bird Study, **1**: 14–17.—Population studies of *Erithacus rubecula*.

LACK, D. 1954. Call-notes, *Erithacus* and convergence. Ibis, **96**: 312–314.—An argument for the maintenance of *Erithacus* as monotypic.

LACK, D., and E. LACK. 1953. Visible migration through the Pyrenees: an autumn reconnaissance. Ibis, **95**: 271–309.

LACK, D., and E. LACK. 1954. The home life of the swift. Scientific American, **191** (1): 60.—A popular account of this group of birds.

LASKEY, A. R. 1954. Blue Jays [*Cyanocitta cristata*] feed tent caterpillar pupae to nestlings. Wilson Bull., **66**: 65–66.

LÖHRL, H. 1954. Gefiedermerkmale bei einer Population des Halsbandschnäppers (*Muscicapa albicollis*). Bonner Zool. Beitr., **5**: 33–48.—A study of variation in plumage of the European Collared Flycatcher based on a population of banded birds. Measurements and descriptions of the plumage of the same birds in different years provide quantitative data on differences between first-year birds and older ones.

MACK, G. 1953. Birds from Cape York Peninsula, Queensland. Mem. Queensland Mus., **13** (1): 1–39, pl. 1.—Annotated list of material collected.

MACDONALD, J. D. 1954. Note on the Double-banded Sandgrouse, *Pterocles bicinctus*. Bull. Brit. Ornith. Club, **74** (1): 6–8.—Three races recognized, one of them new, *P. b. elizabethae*, Spitzkopje, South West Africa.

MACDONALD, J. D., and C. H. B. GRANT. 1953. Early descriptions on new bird species by Andrew Smith. Ann. Transvaal Mus., **22**: 197–203.—Reprinted from The South African Commercial Advertiser, 1828–1829, with comments on the disposition of these names.

MACMULLAN, R. A. 1954. The life and times of Michigan pheasants. Lansing, Mich. Dept. Conservation. 63 pp.—A pamphlet designed to present to the hunter the essential information about the biology and management of pheasants. Clever illustrations by Oscar Warbach help greatly to bring home the ideas to the reader. A very useful piece of work.

MARTIN, P. S., C. R. ROBINS, and W. B. HEED. 1954. Birds and biogeography of the Sierra de Tamaulipas, an isolated pine-oak habitat. Wilson Bull., **66**: 38–57, 2 figs., 1 map, 1 table.—The habitat of this area in eastern Mexico is described and the species of birds, mammals, amphibians, and reptiles are listed. 72 species of birds are listed with notes. About 20 of these species are restricted to pine-oak habitat and are also found in the extensive forests of this type in the Sierra Madre Oriental. Almost none of the other groups of vertebrates had a similar distribution.—J. T. Tanner.

MATTHEWS, G. V. T. 1954. Some aspects of incubation in the Manx Shearwater, *Procellaria puffinus*, with particular reference to chilling resistance in the embryo. Ibis, **96**: 432–440.—Average time for incubation is 53 days. Temporarily deserted eggs were rarely found, but some of those that were contained viable embryos after the parent had not incubated for seven days. Survival was demonstrated in the laboratory for at least 13 days; length of time of chilling (62–76° F.) and stage of development at which it occurred had no relation to the proportion of embryos that survived.

MAYR, E., and E. T. GILLIARD. 1954. Birds of Central New Guinea. Results of the American Museum of Natural History Expeditions to New Guinea in 1950 and 1952. Bull. Amer. Mus. Nat. Hist., **103**: 315–374, pls. 13–34.—*Elanus caeruleus wahgiensis, Cnemophilus macgregorii kuboriensis, Paramythia montium brevicauda*, and *Oreostruthus fuliginosus hagenensis*, new subspecies. This paper contains new information on the displays and display perches of several species of birds of paradise and some remarkable photographs of New Guinea birds.

MONK, J. F. 1954. The breeding biology of the Greenfinch. Bird Study (The Journal of the British Trust for Ornithology), **1**: 2–14.—Breeding season, clutch size, incubation period, and hatching, nestling, and breeding success in *Chloris chloris*. A compilation of data collected by the B. T. O. on over 1000 nests.

MORAN, P. A. P. 1954. The statistical analysis of game-bird records. II. Journ. Animal Ecol., **23**: 35–37.—The annual kill of grouse, ptarmigan, capercailzie, and blackgame show significant correlations, and the annual kill of capercailzie is correlated with minimum winter temperature, May temperature, and mean rainfall for August, September, and October.

MOREAU, R. E. 1953. Migration in the Mediterranean area. Ibis, **95**: 329–364.—There is concentrated use by a few species of the shortest routes across the Mediterranean Sea, but mainly broad-front movement seems to be the rule. Thus, there is movement also across the widest part of the sea, which may be from 430 to 800 miles in distance. Included is an annotated list of the major publications pertaining to migration in countries of the Mediterranean area.

MOREAU, R. E. 1954. The main vicissitudes of the European avifauna since the Pliocene. Ibis, **96**: 411–431.—Ecologic change in the Pleistocene is summarized in the light of recent knowledge. The avian fossil record of Europe is rejected as inadequate for detailing changes in bird distribution in that epoch. The

main conclusion concerning the restriction of bird populations during a glacial maximum is that, for coniferous forest and deciduous woodland, numbers shrank to one-third and one-tenth, respectively, of their interglacial extent. The relationship of these changes to bird migration is discussed.

MORENO, A. 1953. Considerations about the systematic value of *Laterallus jamaicensis jamaicensis* (Gmelin) and *Laterallus jamaicensis pygmaeus* (Blackwell). Torreia, Pub. Ocas. Mus. Poey, Univ. Habana, Cuba, **20**, 8pp.—Black Rails from Jamaica, Cuba, and the United States are considered by Moreno to belong to the same subspecies.

MORENO, A., and R. FERNANDEZ. 1953. Notas ornitologicas No. 6., a). Un nuevo record para las Antillas [*Muscivora forficata*]. b.). Un nuevo record para Cuba [*Sula dactylatra dactylatra*]. c.). El nido y huevos del Ruiseñor [*Myadestes elisabeth elisabeth*]. Mem. Soc. Cubana Hist. Nat. "Felipe Poey," **21**: 247–249.

MUMFORD, R. E. 1954. Brewer's Blackbird [*Euphagus cyanocephalus*] nesting in Indiana. Wilson Bull., **66**: 61–62, 1 fig.

MYRES, M. T. 1953. Some observations on the autumn migration of hirundines through the Austrian Alps. Ibis, **95**: 310–315.

NEWCOMER, E. H., and J. W. A. BRANT. 1954. Spermatogenesis in the Domestic Fowl. Journ. Heredity, **45** (2): 79–87.

NEWTON, R. 1954. American land-birds and other species seen in the North Atlantic. Ibis, **96**: 484.

OGLESBY, C. V., and F. A. GLOVER. 1954. Body temperatures of botulistic Pintails. Condor, **56**: 162–163.—The mean body temperature for pintails before treatment for botulism was 101.8° F., and after recovery it was 106.6.

OWEN, D. F. 1954. The winter weights of titmice. Ibis, **96**: 299–309.—1500 weights of trapped and banded titmice, mainly *Parus caeruleus*, *P. major*, and *P. ater*, were obtained at Oxford, England, in the winter of 1951–1952, and in November and December, 1952.

PARKES, K. C. 1954. Notes on some birds of the Adirondack and Catskill mountains, New York. Ann. Carnegie Mus., **33**: 149–178.—*Regulus calendula* and *Hesperiphona vespertina* found nesting in the Adirondacks. *Surnia ulula* and *Perisoreus canadensis* recorded from the Catskills in winter. The author believes that the proposed merging of *Dendrocopos* and *Picoides* and of *Passerella* and *Melospiza* should be rejected and that the subspecies, *Parula americana pusilla*, *Dendroica striata lurida*, and *Geothlypis trichas brachidactyla*, should not be recognized.

PARKES, K. C. 1954. A revision of the neotropical finch *Atlapetes brunnei-nucha*. Condor, 56: 129–138.—In revising this species four new subspecies are described: *suttoni*, *macrourus*, *alleni* and *elsae*. The species *apertus* is considered to be a subspecies of *brunnei-nucha*, and characters and distribution are defined for other subspecies: *brunnei-nucha*, *frontalis* (= *xanthogenys*), *inornatus*, and *allinornatus*.—D. W. Johnston.

PARTRIDGE, W. H. 1953. Observaciones sobre aves de las provincias de Córdoba y San Luis. El Hornero, **10**: 23–73.—Annotated list of species from two provinces of Argentina.

PARTRIDGE, W. H. 1953. Notas breves sobre aves del Paraguay. El Hornero, **10**: 86–88.—*Accipiter poliogaster*, *Elaenia albiceps chilensis*, and *Amaurospiza moesta*.

PARTRIDGE, W. H. 1953. Nuevos hallazgos de la garza pico cuchara en la Argentina. El. Hornero, **10**: 88–89.—Records of *Cochlearius* in the Argentine.

PATERSON, M. 1954. The identity of *Cinnyris afer whytei* Benson. Bull. Brit. Ornith. Club, **74** (3): 35–36.—Believed to be a race of *C. chalybea*.

PHILLIPS, A. R. 1954. The cause of partial albinism in a Great-tailed Grackle. Wilson Bull., **66**: 66.—In *Cassidix mexicanus*, a fibrous cyst was present surrounding a sliver below the albino area.

POTTER, N. S., III. 1953. The birds of Calicoan, Philippine Islands. Wilson Bull., **65**: 252–270.—Notes on 51 species.

PUTNAM, L. S., and C. E. KNODER. 1953. Five nestings of a pair of captive Mourning Doves. Wilson Bull., **65**: 280.—A pair of captive *Zenaidura macroura* nested 5 times, 4 times successfully, between early April and mid-August.

RICHDALE, L. E. 1954. Breeding efficiency in Yellow-eyed Penguin. Ibis, **96**: 207–224.—Hatching success in *Megadyptes antipodes* with relation to age of birds was known for 733 nests in 17 seasons on the Otago Peninsula, New Zealand. These birds acquire adult plumage during the age 14 to 18 months, but are not then sexually mature. 48 per cent of two-year-old females breed, and most of the remainder the following year. Fertility in two-year-old females was 18 per cent; in three-year-olds, 82 per cent; in four-year-olds, 95 per cent; in birds 5 to 15 years, 93.7 per cent; in older birds, 91.7 per cent. Survival of chicks is apparently unrelated to the age of the parents.

Two-year-old males almost never breed; in those that do fertility is markedly low. Three-year-old males are probably not as fertile as three-year-old females. Thus, there is apparent in these penguins a tendency toward adolescent sterility. This phenomenon strongly resembles that described for certain mammals.

ROBINSON, T. S. 1954. Cannibalism by a Burrowing Owl [*Speotyto cunicularia*]. Wilson Bull., **66**: 72.

ROSCHE, R. C. 1954. Notes on some birds of Yellowstone National Park. Wilson Bull., **66**: 60.

SAGE, B. L. 1954. Symmetrical albinism in birds' wings. Bull. Brit. Ornith. Club, **74** (1): 9–10.

SANDNES, G. C. 1954. A new technique for the study of avian chromosomes. Science, **119** (3094): 508–509.

SCHOLES, R. T., and K. T. SCHOLES. 1954. Notes from Panamá and the Canal Zone. Condor, **56**: 166–167.—Seven species of importance are mentioned.

SICK, H. 1950. Contribuição ao conhecimento da ecologia de "Chordeiles rupestris" (Spix) (Caprimulgidae, Aves). Rev. Brasil. Biol., **10**: 295–306.—On the ecology of *Chordeiles rupestris*. In Portuguese with summary in English.

SICK, H. 1953. Anotações sôbre cucos Brasileiros (Cuculidae, Aves). Rev. Brasil. Biol., **13**: 154–168.—Notes on *Tapera naevia, Dromococcyx phasianellus, D. pavoninus* and *Neomorphus geoffroyi*. In Portuguese.

SIMMONS, K. E. L. 1953. Some aspects of the aggressive behaviour of three closely related plovers (*Charadrius*). Ibis, **95**: 115–127.—*C. dubius, C. alexandrinus*, and *C. hiaticula* are generally compared.

SKEAD, C. J. 1954. A study of the Cape Wagtail, *Motacilla capensis*. Ibis, **96**: 91–103.—General life history, with specific data from a recognizable, partly albino female, at Grahamstown, South Africa. The breeding season is usually August to November, clutch size about 3.3 eggs, incubation period about 13.5 to 14.5 days, and nestling period 14 to 18 days.

SKUTCH, A. F. 1953. How the male bird discovers the nestlings. Ibis, **95**: 1–37; 505–542.—A detailed, occasionally anthropomorphic, account of how males of 14 species of mainly Costa Rican birds came to discover their newly-hatched young and began to feed them. The males have to discover the nestlings by themselves, since female birds apparently do not communicate the news of hatching to them.

SNOW, D. W. 1953. Visible migration in the British Isles: a review. Ibis, **95**: 242–270.

SNOW, D. W. 1954. Trends in geographical variation in Palaearctic members of the genus *Parus*. Evolution, **8**: 19–28, 5 figs., 2 tables.—In *Parus* geographical variation is closely related to climate. Size increased as the mean winter temperature decreased. The wing length was found to be a satisfactory indication of general size. Mean size is greater (in populations inhabiting areas with similar mean winter temperatures) at low latitudes than at high. The relative lengths of beak and tarsus were found to decrease in the colder parts of the range of a species up to a certain point, beyond that colder temperatures did not result in further shortness. It is shown that similarity of color may exist in widely separated parts of the range of a species as the result of selection due to similar climates rather than close phologenetic relationship.

SNYDER, D. E. 1954. A nesting study of Red Crossbills. Wilson Bull., **66**: 32–37.—Observations on a nest of *Loxia curvirostra* in eastern Massachusetts.

SOUTHERN, H. N. 1954. Tawny Owls and their prey. Ibis, **96**: 384–410.—An excellent report, mainly by means of analysis of cast pellets in conjunction with a population study, of the diet over eight years of 20 pairs of *Strix aluco* in a woodland near Oxford, England. Small rodents predominate in the diets in winter and spring and larger mammals in the summer and autumn; birds and shrews are taken at a constant rate throughout the year. The owls take only prey species found closely around them. The author suggests that these owls can survive only if they hold a territory and are intimately familiar with it.

STAEBLER, A. E. 1954. Two Mallard ducks [*Anas platyrhynchos*] caring for the same brood. Wilson Bull., **66**: 69–70.

STANFORD, J. K. 1953. Some impressions of spring migration in Cyrenaica March–May 1952. Ibis, **95**: 316–328.

STANFORD, W. P. 1953. Winter distribution of the Grey Phalarope *Phalaropus fulicarius*. Ibis, **95**: 483–491.—Heaviest concentrations off NW Africa occur in seas with dense plankton populations. There is postulated a parallel situation in Cape waters, analogous to that off South America.

STEINBACHER, J. 1954. Die Typen der Vogelsammlung von F. H. von Kittlitz. Senckenbergiana, **34**: 301–305.

STEINBACHER, J. 1954. Über die Sperlings-Formen von Sardinien und Sizilien. Senckenbergiana, **34**: 307–310.

SUMMERS-SMITH, D. 1954. The communal display of the House Sparrow, *Passer domesticus*. Ibis, **96**: 116–128.—Communal display, involving one female and two to ten male House Sparrows, apparently arises as a result of a male attempting to mount a female not ready for copulation. In the ensuing chase other males are attracted. The author believes communal display in this species is a true sexual display, serving to bring not only pairs but all members of a flock into breeding condition synchronously.

SVÄRDSON, G. 1953. Visible migration within Fenno-Scandia. Ibis, **95**: 181–211.

TAYLOR, J. 1953. A possible moult-migration of Pink-footed Geese. Ibis, **95**: 638–641.

THOMPSON, A. L. 1953. The study of the visible migration of birds: an introductory review. Ibis, **95**: 165–180.

THORPE, W. H. 1954. The process of song learning in the chaffinch as studied by means of the sound spectroscope. Nature, **173** (4402): 465–469, 5 figs.—This is an important paper that describes the use of modern techniques on an old problem. From a study of hand-reared birds it is concluded that the normal

3-phased song of the chaffinch has an inborn basis amounting to little more than the ability to produce a song of normal length and a crescendo series concluded by a single note of high pitch. All further refinements have to be learned although the innate basis is sufficiently selective to ensure that notes or songs of other species are not acquired. Some learning takes place during the first weeks of life, especially the first part, but details of phase three are not acquired. The latter is learned later when singing in competition with other chaffinchs. This results in formation of a community "pattern" and explains local variations of the song in the wild.

TIMMERMANN, G. 1954. The present status of Icelandic ornithology. Bull. Brit. Ornith. Club, **74** (1): 1–5.—An interesting analysis of the composition of the Icelandic avifauna.

TINBERGEN, N. 1953. The evolution of mating behavior patterns. Evolution, **7**: 391.—Author's comments center on Spieth's (1952) study of Drosophila mating behavior with brief mention of Anatidae and *Larus*.

TODD, W. E. C. 1954. A new gallinule from Bolivia. Proc. Biol. Soc. Wash., **67**: 85–86.—*Gallinula chloropus hypomelaena* (Vacas, Dept. Cochabamba), new subspecies.

VALVERDE, J. A. 1953. Contributions à la biologie du Coucou-geai, *Clamator glandarius*. L'Oiseau, **23**: 288–296, figs. 1–2.—Notes on the food and breeding in Spain.

VAN DOBBEN, W. H. 1953. Bird migration in the Netherlands. Ibis, **95**: 212–234.

VAN NESS, G. A. 1953. Weather influence in blue comb in chickens. Science, **118** (3072): 601–602.

VAN OORDT, G. J., and J. P. KRUIJT. 1953. On the pelagic distribution of some Procellariiformes in the Atlantic and Southern oceans. Ibis, **95**: 615–637.—Dealing with eleven species, this paper covers the distribution in winter of certain species of the North Atlantic and in summer of certain species of the Antarctic, as well as migratory movements in the Southern Ocean.

VAN TIENHOVEN, A., A. V. NALBANDOV, and H. W. NORTON. 1954. Effect of Dibenamine on progesterone-induced and "spontaneous" ovulation in the hen. Endocrin., **54**: 605–611, 2 tables.

VESELOVSKÝ, Z. 1953. Postembryonální vývoj našich divokých kachen. Sylvia, **14**: 36–73.—The postembryonic development of *Aythya fuligula*, *A. ferina*, *A. nyroca*, *Anas platyrhynchos*, *A. crecca*, and *Spatula clypeata*. In Czech with German summary.

VESELOVSKÝ, Z. 1953. Příspěvek k poznání postembryonálního vývoje nandu (*Rhea americana*). Sylvia, **14**: 82–90.—The postembryonic development of the Nandu. In Czech with a German summary.

WALLMO, O. C. 1954. Nesting of Mearns Quail in southeastern Arizona. Condor, **56**: 125–128.—For *Cyrtonyx montezumae mearnsi*, descriptions are given for several nests and their contents and habitat requirements.

WEBSTER, J. D., and R. T. ORR. 1954. Summering birds of Zacatecas, México, with a description of a new race of Worthen Sparrow. Condor, **56**: 155–160.—Thirty-two species are mentioned, most of which were heretofore unrecorded from the state. *Spizella wortheni brownı* is described as a new subspecies.

WETMORE, A., and G. M. SUTTON. 1953. The Carolina Chickadee in Kansas. Wilson Bull., **65**: 277.—Correcting an erroneous locality record results in a change in the stated northern limit of *Parus carolinensis atricapilloides* in Kansas.

WHITE, C. M. N. 1954. Racial variation in *Eupodotis melanogaster* (Ruppell).

Bull. Brit. Ornith. Club, **74** (1): 5.—It is suggested that no subspecies should be recognized.

WIGGINS, I. L. 1954. The Gray-cheeked Thrush at Point Barrow, Alaska. Condor, **56**: 163.

WILLIAMS, G. R. 1953. The dispersal from New Zealand and Australia of some introduced European passerines. Ibis, **95**: 676–692.—13 species have, mostly unaided by man, established themselves variously on 9 islands lying 200 to 550 miles offshore from New Zealand and Australia. Strong winds are suspected of carrying the birds, mainly from New Zealand.

WILLIAMS, G. R. 1954. Population fluctuations in some Northern Hemisphere game birds (Tetraonidae). Journ. Animal Ecol., **23**: 1–34.—One synchronized 9 to 10 year cycle covers most of Canada, but the cycle in the Maritime Provinces is advanced 3 years and that in Alaska is retarded 3 years compared with the main one. This cycle is correlated with that of the snowshoe rabbits and is possibly controlled by weather factors. The cycle in Britain is 5 years, in Finland and Scandinavia, it is 3 to 4 years and correlated with that of the lemmings.

WILLIAMS, J. G. 1953. Revision of *Cinnyris sovimanga:* with description of a new race. Ibis, **95**: 501–504.—*C. s. buchenorum*, Aldabra Arch., Indian Ocean, new subspecies.

WOLFE, L. R. 1954. Nesting of the Laughing Falcon. Condor, **56**: 161–162.—Several nests, their sites and contents are described for *Herpetotheres cachinnans* in Mexico.

WOLFSON, A. 1954. Notes on the cloacal protuberance, seminal vesicles, and a possible copulatory organ in male passerine birds. Bull. Chicago Acad. Sci., **10**: 1–23.

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NOTES AND NEWS

WITH the completion of this volume of 'The Auk,' I am pleased to acknowledge and thank the many people who have assisted in preparing it. The members of the Editorial Committee have continued their helpful work, and I am particularly grateful to A. J. Berger, W. R. Dawson, and P. S. Humphrey for finishing the July issue during my absence. Mrs. Jane Gabel, Miss Elsa Hertz, Mrs. Helen M. Staebler, and L. C. Binford have done secretarial work, read proof, and offered valuable suggestions.

The Committee of Biography and the many contributors to the recent literature section have continued their good work, and William A. Lunk has again prepared several illustrations. Colonel L. R. Wolfe has kindly prepared the index. Alden H. Miller and A. Starker Leopold have edited important manuscripts. Josselyn Van Tyne has again given much valuable time and advice.

Finally, I wish to express my appreciation to those who have contributed money toward the publication of 'The Auk.' The costs of publication continue to rise, and it is increasingly difficult to remain within our budget.

SEVENTY-THIRD STATED MEETING

THE seventy-third stated meeting of the A.O.U. will be held in Boston, October 25 to 30, 1955. Registration will begin on the first day, there will be three days for the program, and the meeting will conclude with two days of field trips. The chairman of the local committee on arrangements is C. Russell Mason, 1376 Walnut Street, Newton Highlands, Massachusetts.

Tentative plans have been made to hold the seventy-fourth stated meeting in Denver.

THE American Ornithologists' Union has joined a distinguished list of organizations in affiliating with the American Institute of Biological Sciences. This affiliation, voted at the 1953 A.O.U. meeting, became effective January 1, 1954.

The American Institute of Biological Sciences was organized in 1948 under the sponsorship of the National Research Council. It was formed to provide a unifying agency for the separate organizations in the biological sciences.

One of the benefits to A.O.U. members from this affiliation is the opportunity to register with the Placement Service at a reduced fee. Registration brings publication of a resume of qualifications in four quarterly lists distributed to prospective employers. The cost to members of affiliated organizations is $5.00; the cost to non-members is $10.00. For further information write Placement Service, American Institute of Biological Sciences, 2102 Constitution Avenue, Washington 25, D. C.

BRITISH ORNITHOLOGISTS' UNION

The British Ornithologists' Union was founded in 1858 for the advancement of the science of ornithology. Its quarterly journal 'The Ibis' contains up to six hundred pages per year of original matter embracing the whole field of international ornithology. At intervals numbers are devoted to particular subjects such as migration, ecology, and behavior, with authoritative contributions from distinguished specialists throughout the world. Each issue contains a large number of critical notices of recent ornithological literature, classified by subjects. Scientific meetings are arranged, and in international ornithology the Union plays a leading part.

The annual subscription to the British Ornithologists' Union is £3 and the Hon. Secretary will be glad to send particulars and to welcome prospective American members.

British Ornithologists' Union
c/o Bird Room, British Museum (Natural History)
London, S.W.7., England

LETTER TO THE EDITOR OF 'THE AUK'

Dear Dr. Storer:

During the present critical period in the conservation movement, I am anxious to keep in touch with all A.O.U. members who are interested in helping promote better protection and management of our natural resources.

For that purpose I have for the past several years maintained a list of those known to me to be interested and have received prompt and effective response to information furnished them. The coming years promise to be no less critical and I would be glad to add to this list anyone interested in helping. A note to me at my office, 709 Wire Building, Washington 5, D. C., will put another name on the list.

Sincerely,
Ira N. Gabrielson
President, Wildlife Management Institute

OBITUARIES

WALLACE CRAIG, elected an Associate of the American Ornithologists' Union in 1912, died at Woods Hole, Massachusetts, April 25, 1954. He was born in Toronto, Canada, July 20, 1876. Following undergraduate work at the University of Illinois, he received an M.S. from this school in 1901. From 1902 to 1904 he was Assistant in Zoology at the University of Chicago, where his Ph.D. was granted in 1908. After holding the chair of philosophy at the University of Maine from 1908 to 1922, he went to Harvard as lecturer in psychology. Various positions were held in this institution from 1922 until his retirement in 1947. Private research was done by him during the last 25 years of his life.

Craig's interest lay mainly in animal psychology. He published a score of valuable papers on avian behavior, a subject that has become a catch-all for everything that a bird does. Most of his writings appeared in Science (1902; 1908; 1944), Biological Bulletin (1904; 1918), American Journal of Sociology (1908), Journal of Morphology (1910), Journal of Comparative Neurology and Psychology (1909), Auk (1911; 1912; 1913; 1926; 1933), Journal of Animal Behavior (1912; 1913; 1914), and Bird-Lore (1913). Due to his association with Prof. C. O. Whitman of Chicago much of his work was devoted to the Columbidae. This was most fortunate for science since otherwise the details of the behavior of the Passenger Pigeon would never have been known. He collaborated with O. Riddle and H. A. Carr in publishing Whitman's 'Posthumous Works' (1919). His first paper was 'Song in Birds' (1902) and the voices of birds continued to hold his attention. His 'The Song of the Wood Pewee . . . A Study of Bird Music' (N. Y. State Mus. Bull. No. 334, 1943: 186 pp.) is the most detailed of the song of any species that has been published. He was not content with the music alone, but considered the psychological and esthetic aspects as well. An unfinished manuscript on space perception in animals was left by him.—A. W. SCHORGER.

AUSTIN PARK LARRABEE, an Associate of the American Ornithologists' Union, elected in 1918, died in a hospital in Seattle, Washington, on May 4, 1954. He was born in Gardiner, Maine, on January 26, 1876. Following his undergraduate work at Bowdoin College, he received an M.A. from Harvard in 1903 and a Ph.D. from Iowa in 1927. After teaching at Bowdoin, Harvard, high schools in Utah and California, and Fairmont College, he became Professor of Biological Sciences at Yankton College, South Dakota, in 1916. On retiring from this position in 1949, he made his home in Medina, Washington.

He was a member of the Wilson Ornithological Club, Audubon Society, American Society of Mammalogists, and the South Dakota Academy of Science. Although his special field was ecology, he was interested in ornithology, ichthyology, and genetics. His papers appeared in the Journal of the Maine Ornithological Society, Maine Sportsman, Wilson Bulletin, University of Iowa Studies, and the Proceedings of the South Dakota Academy of Science. He is survived by his wife and three children.—A. W. SCHORGER.

FRANK MILLS PHELPS, an Associate of the American Ornithologists' Union, elected in 1912, died in Elyria, Ohio, November 5, 1953. He was born in that city June 4, 1885. His education was received at the Elyria High School and Ohio State University. The building and loan business in Cleveland occupied his attention for 30 years, and for 10 years prior to his retirement in 1952, he was associated with the Bendix-Westinghouse Company in Elyria.

The study of nature, especially birds, interested him since childhood. He belonged to several local nature groups and the Cleveland Audubon Society. He was long a member of the Wilson Ornithological Club and served as its treasurer from 1917 to 1919. His first paper, 'The Resident Bird Life of the Big Cypress Swamp Region,' appeared in the Wilson Bulletin (26: 86, 1914). Extensive travels made him acquainted with the birds of many regions. Among the places visited were: Florida, Bonaventure Island, Alberta, Magdalene Islands, Bird Rock, Stokes Bay, Tobermory, and Burk's Falls (the last three being in Ontario), Chisos Mountains and Waggoner Ranch, Texas, Mosquero, New Mexico, and Carr Canyon, Arizona. As a result of his wide knowledge of birds, he was in great demand as a speaker before nature clubs.—A. W. SCHORGER.

SAMUEL ALBERT WHITE, a corresponding Fellow of the American Ornithologists' Union since 1919, died at Adelaide, South Australia, on January 20, 1954, at the age of 83 years. He was born in Adelaide on December 21, 1870. He was a past President of the Royal Australasian Ornithologists Union and also of the South Australian Ornithologists' Association and a Corresponding Member of the British Ornithologists' Union.

White had been a student of birds since boyhood. His father, Samuel White, who reached South Australia from London as a lad of seven years (in 1842), had early become attached to ornithology and had given John Gould useful notes arising from several long and hazardous expeditions which he made from 1860 onward. S. A. White was only 10 years of age when (in 1880) his father died, but a few years later he too carried out expeditions into Australia's interior in search of birds.

Following service in the South African War—during which he won decorations and attained the rank of captain—White did some bird-collecting in East Africa and subsequently he divided his time chiefly between pastoral activity, service as Chief Commissioner of Boy Scouts in South Australia, and ornithological research in various parts of Australia. He collected extensively and, although not a skilled writer, published many papers, also sending numerous notes to G. M. Mathews for his "Birds of Australia."

White's chief characteristics were enthusiasm, energy, and devotion to his father's memory. He was married twice (his first wife died in 1926) and is survived by his widow, a son, and a daughter.—A. H. CHISHOLM.

FRED J. PIERCE has been editor of Iowa Bird Life for 24 years, and is head of the Pierce Book Company which deals in Natural History books. He is author of hundreds of articles on birds, and editor of Althea Sherman's book, "Birds of an Iowa Dooryard." He has been a student of birds for 37 years, and his contributions to the field have been honored by his election (one of 200 in America) to "Member" of the American Ornithologists' Union.

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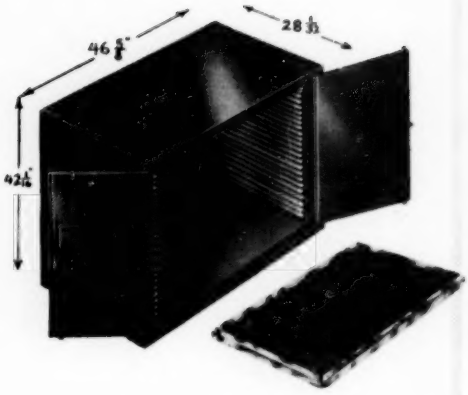

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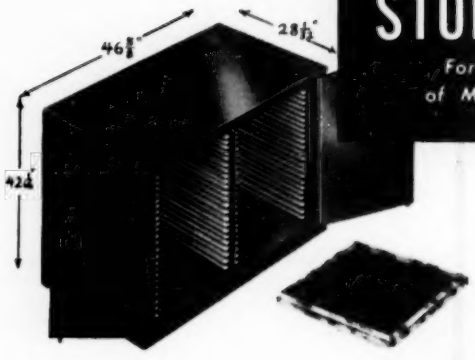

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All articles and notes submitted for publication and all books and publications intended for review should be sent to the Editor.

ROBERT W. STORER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

All persons interested in ornithology are invited to join the American Ornithologists' Union. Application may be made to the Treasurer; dues for Associates are $4.00 per year. 'The Auk' is sent without charge to all classes of members not in arrears for dues.

Send changes of address, claims for undelivered or defective copies of 'The Auk,' and requests for information relative to advertising, subscriptions, back numbers of 'The Auk,' as well as for other publications of the Union, to the Treasurer.

CHARLES G. SIBLEY, *Fernow Hall, Cornell University, Ithaca, New York.*
